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CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 225

ILLUSTRATED ARTICLES:
Self-Starting and Self-Exciting Synchronous Alternating Current Motors, by Lieut. F. Jarvis Patten ... 226
Dynamic Induction at High Potentials and Frequencies, by Elihu Thomson ... 226
The Sprague Pratt Electric Elevator ... 228
A Watchman's Time Detector ... 229
A Revolving Fan Motor ... 229
Electric Lighting of Vehicles ... 229
Cazal's Gearless Electric Railway Motor of 1864 ... 229
Track Bonding and Overhead Railway Construction, by Jay Wiley ... 230
Notes on Electromagnetic Machinery: IV.—by W. S. Aldrich ... 231
Application of the Weston Voltmeters and Ammeters to Practical Electrical Measurements: II.—by H. Maschke ... 233
Lightning Arresters and the Discovery of Non-Arcing Metals: II.—by Alexander J. Wurts ... 235
An Improved Friction Clutch ... 236
Thomson-Houston Standard Switches and Crossings ... 236
A Stage Regulator Switch ... 236

MISCELLANEOUS:
Early Transmission of Power Experiments with High Tension Transformers ... 226
Oil as an Insulator, by Prof. D. E. Hughes ... 232
Works of the Washington Carbon Company ... 236

FINANCIAL INTELLIGENCE: The Electrical Stock Market, 236; New Incorporations, 237; Affairs of the Companies, 237.

SPECIAL CORRESPONDENCE: New York Notes, 237; Philadelphia Notes, 238; New England Notes, 238; Western Notes, 238; English Notes, 238; Inquiries from Correspondents, 239; Answers to Correspondents, 239.

NEWS OF THE WEEK: The Electric Light, 239; The Electric Railway, 239; Miscellaneous, 239.

INDUSTRIAL AND TRADE NOTES ... 240

BUSINESS NOTICES ... 240

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 240

Electric Railroad Construction.

MOST of the current literature on electric railroads has dealt chiefly with the descriptions of apparatus or discussions of the commercial features involved, while the subject of the construction of a road from the standpoint of the contractor who does the actual work of erecting the line has been almost neglected in the voluminous literature on electric railroads. This may be due to the fact that until now this work has been confined chiefly to the few companies who erect such plants and who, being in a measure rivals, do not care to "give away their points." But with the enormous field now opened for electric railroad work this part of the erection will gradually drift into the hands of local contractors, and it will be an advantage to all concerned to fully discuss the practical details of the work. To keep such practical hints, rules and devices a secret, is a very narrow-minded policy. Just as it is in the interest of parent electric light companies to give local contractors as much free instruction and advice as possible in regard to wiring buildings, so it will be in the interest of the parent electric railroad companies, whose name a plant will bear, that the local contractors receive as much advice and instruction from them as possible. We publish in this issue a practical paper on this subject and trust it will be followed by discussions and contributions from those readers who have experience in this line of work. Such discussions can result only in mutual advantage to all concerned.

Oil as an Insulator.

THE question of the right to use oil as an insulator may be stated to be settled beyond a doubt. No valid, broad patent can possibly exist, and the right to use this cheap and valuable insulating material is therefore free to everybody. This may have been known to a few who have examined the subject of its patentability, but it is perhaps not generally known, as there exist in the United States broad and unexpired patents for it. In another column will be found an abstract of an interesting article by Prof. Hughes showing that he discovered and patented it 33 years ago. His idea was to obtain a self-restoring insulating medium for cables, that is, one in which a puncture would heal up by itself. This it will be remembered was just what David Brooks' invention was. Brooks is generally credited with this invention in this country, and he was doubtless an original inventor, though many years later than Hughes; it is nevertheless curious to see how very similar their researches were. Both concluded that rosin oil was the best. In Brooks' later researches he used a very heavy oil, one which was heavier than water, so that the water entering into a cable or pipe would float, and therefore be ejected if there was an opening for it to pass out. Hughes, who, by the way, we can claim as an American though now in London, now receives the glory as the first inventor, while Brooks received the shekels for the invention. It may be interesting to add here that Du Moncel* speaks of the use of the oil of turpentine as an excellent insulator for Ruhmkorff coils, as early as 1857 and 1858. But even before this Faraday used the oil of turpentine as an insulator.

Re-invention.

How much time would be saved and how much less useless work would be done if inventors and discoverers first studied, as far as possible, what others had done before they begin their inventing; that is, if they would begin where others have left off instead of re-inventing the same things, or, to use electrical terms, if inventors would work in series instead of in parallel. It happens so often that as soon as an invention or discovery proves to be good many claimants of priority crop up. A prior claimant who has published his work can refer to it with right and with just pride; the re-inventor must then retreat. We recall an American inventor, whose name is not unfamiliar to many, who shut himself up in a laboratory without books and started to invent prolifically, as some inventors do. He then applied for patents and was shown that most of his work was described in Faraday's researches. Perhaps he thought himself a second Faraday, but he cannot claim any recognition as such from others, who would simply smile at such pretences. Our patent office has done much good work in searching back records and thereby preventing the issue of patents which could not be sustained, but its record is not entirely free from mistakes. A certain patent was issued and sold for quite a large sum. Long after the sale it was discovered that the same thing had been invented in England long ago. The re-inventor in this case was the lucky one, and as he was, doubtless, an original inventor of that particular thing, he deserved the money he made by it. Such transactions, however, might lead to grave complications and might be avoided by a more careful search on the part of the patent office examiners.

Early Discoverers of the Rotating Field.

SINCE the discovery of the rotating field by Ferraris, Tesla, Bradley and others has become generally known, the inevitable prior inventor crops up in different forms. In the year 1880 Mr. M. W. de Fonville and Mr. Lontin brought before the French Academy of Sciences an apparatus which they called an electromagnetic gyroscope, and which they now bring forth as a prior invention to that of Mr. Ferraris. The apparatus consisted of a galvanometric coil in the centre of which were placed, on a pivot, various objects of soft iron, as a disc or a needle. Above the coil was suspended on a pivot a permanent steel horseshoe magnet, the two poles of which were nearly on a level with the iron disc. When the current from a Ruhmkorff coil was led through the coil, the soft iron disc rotated. Further details may be found by those interested in *Cosmos*, 18th and 25th of January, 1890, and Sept. 22, 1891. Marcel Deprez also appears as a claimant. He claims to have invented it in 1883 and obtained a patent for it in May of that year. He speaks of the magnetic field produced by a circulating current around a Gramme ring. He claims that such a rotating field can be produced without any movable parts, by generating the field with two currents, which are led into a stationary Gramme armature at the ends of two perpendicular diameters. The magnetization, he states, is then the resultant of that produced by the two currents. By varying the relative strengths of these two currents the field may be made to revolve. In his patent, however, he does not mention using alternate currents differing 90 degrees in phase, which is really the essence of the invention of Prof. Ferraris; nor does he speak of the advantage of utilizing such a revolving field to develop induced currents, the reaction of which will set into motion a revolving armature.

High Potential Experiments.

THE researches which have been made during the past year upon high potential discharges of very great frequency have opened up a new and very interesting field which, though yet in its infancy, may prove to be of great importance. Tesla is endeavoring to utilize such discharges for the production of cheap light and has already accomplished exceedingly interesting results in this direction. Prof. Elihu Thomson, who has occupied himself so much with lightning arresters, has been experimenting with these currents in this direction. Such discharges, of 2½ and 3 feet, which he describes in the paper, given elsewhere in our columns, may truly be said to be harnessed artificial lightning on a small scale. Much interesting work has doubtless been done in this field, and we are pleased to see that one of the ablest workers in this country is contributing a description of some of his experiments for the benefit of many interested readers. The liberal policy of giving the public the advantage of private researches is, we regret to have to admit, more customary abroad than in this country, and it is probably for this reason that an impression exists abroad that we have few scientific workers. Let us hope that this good example will be followed by others. It is more creditable to describe one's researches when they are new than to wait until some one else does the same thing, and then claim that so and so did this or suggested that, years ago. We call especial attention to the very excellent photograph of the 30-inch discharge, which we reproduce on another page. The original photograph is one of the finest that has ever come to our notice. The exposure was about a second and a half. The photograph is especially interesting because it shows really more than can be seen with the eye, to which all these fine ramifications are invisible, the sparks appearing as broad and thick lines owing to their great brightness.

The Trolley in Philadelphia.

PHILADELPHIA is the next in line to consider the introduction of the overhead trolley system. Councils have just passed ordinances allowing seven of the railway companies to use the overhead trolley system. This includes the greater part of the city railways, and means the introduction of about 10,000 poles. The size of this project will be appreciated from the fact that Philadelphia, with its 510 miles of street railways, not only leads all the cities in the United States and of the world, but, with the exception of Chicago—which has 452 miles, Philadelphia has almost double that of any other city in the Union; it has almost as many miles as New York and Brooklyn combined. The ordinances, however, are not yet a law, as they still require the mayor's signature. A town meeting was held—the largest of its kind ever held in Philadelphia—to protest against these ordinances, and to appeal to the mayor to veto them. It should be clearly understood, however, that the opposition was not directed toward electrical systems *per se*, but to the indecent haste made by Councils in view of the citizens' protest meeting to be held the day following. It was directed more particularly to the nature of these ordinances, which provide for practically no protection against dangers, nor for the payments for the franchises. The number of passengers carried annually in that city is stated to be 160,000,000, which represents probably over $7,500,000 as an annual income. Such a franchise is certainly worth paying something for. This action of Councils is one of the worst pieces of legislation ever enacted in Philadelphia, and it cannot fail to do great harm to the progress of electrical railroading and to bring much undeserved discredit on electrical systems in general. The people are led to believe that all electrical railways are objectionable. The movement to introduce the trolley system comes, of course, from the companies and not from the people. The companies will benefit because their profits will be greater. Rapid transit in narrow streets where the traffic is dense is a delusion and a snare, and reflects with discredit and suspicion on any one advocating this as a reason for introducing a new system. In suburbs and on wide streets with few crossings this does not apply. As there are in operation other systems which do not possess these alleged objections to the overhead trolley wire, the citizens merely demanded that a commission be appointed to examine and report on these systems, before taking any hasty action. The very fact that the railway companies object to such examinations shows that they themselves believe that there are other satisfactory ways which, however, are objectionable to them because they are more expensive. Washington and Chicago both protest against the overhead trolley system, and are introducing storage batteries and the Siemens & Halske conduit system, which appears to be in successful operation in Budapest. Rapid transit on the narrow streets in the heart of Philadelphia being out of the question, the citizens demand that a less objectionable method of propulsion be used. When such protests as these are raised in most of the large cities against the overhead trolley, electrical railway companies will do well to hurry a little in their endeavors to devise successful underground and storage battery systems. It is not very creditable to American engineers to have a foreign company come here to show us how to build a successful conduit road. Whatever may be said in favor of the overhead trolley system, all of which it doubtless deserves, it is not altogether free from objections, especially in cities having such large quantities of bare overhead telegraph and telephone wires, and we ought therefore not to consider it a system which cannot be improved upon. The chief objection to the underground conduit system is the difficulty to provide for drainage, but to drain a conduit is a mere matter of good civil engineering, and to say we cannot do it would be to admit that we have no competent civil engineers in this country, an admission which we are hardly required to make.

* "Exposé des Applications de Eléctricité," 1862, Vol. IV., p. 49.

Self-Starting and Self-Exciting Synchronous Alternating Current Motors.

BY LIEUT. F. JARVIS PATTEN.

It is not my purpose in this article to excite discussion, but merely to explain what appears to me the fallacy of an opinion that seems to be quite generally entertained that there exists as yet no self-starting alternating current motor of the synchronous type, exclusive of the rotary field machine, which may be also broadly classed as synchronous. Another opinion certainly unsound, though quite generally accepted, is that the alternating motor when in synchronism must necessarily run at the speed of the dynamo supplying the current, the term synchronism being supposed to imply identical speeds of driving and driven machines. An author whose name I do not now recall, has enlarged upon this notion to the extent of saying that the armature of the dynamo should be given great fly-wheel action, so as to respond but slowly to changes of engine speed, while the motor armature should have as little fly-wheel action as possible, so as to respond quickly to changes of dynamo speed. Certainly such fine points of engineering construction would lose much of their practical value if the synchronous motor could be made to run at one-half, one-fourth, or one-eighth of the dynamo speed, and yet be in synchronism with the latter.

I have built many such machines since June, 1889, when I first obtained good practical results from a type of machine that has been described a number of times in the different electrical journals of this country and England. They have all been self starters, and may be given a wide range of speed differing from that of the dynamo and yet be in perfect synchronism with it. Yet I continue to find in the daily literature of this subject such statements and queries as the following, which I take at random from a recent number of THE ELECTRICAL WORLD, and from Mr. Stanley's recent able paper on alternating motors at the Buffalo convention:

"Regarding the synchronous system it is very desirable to know whether a convenient and simple starting apparatus is available."

"How to start a synchronous motor is a problem that is still unsolved," and

"Had we a reliable means of dividing an alternating current in two currents having the proper phase difference, the Tesla motor would be available and of great commercial value."

A brief description of the type of machine I have frequently built and which has many interesting functions and applications would seem a fitting reply to statements and queries like those quoted above.

It consists merely of a Gramme winding in a single field, differing from the ordinary Gramme machine only in the method of connecting the winding to the segments of the collector, the inner one, upon which bear the brushes b_1 b_2, Fig. 1, being here referred to. The machine has another collector shown outside the first for convenience of illustration, which is connected in the ordinary way. Such a system of connections might be mistaken for a Siemens winding, which it resembles closely, but it is a very different affair. It is a Gramme winding in which every other segment of the collector is connected to a point of the winding diametrically opposite to the segment, while the intermediate segments of the collector are connected to adjacent points of the winding. This system of connecting together with an added collector, which is connected in the ordinary way as shown, produces results that are often desirable. To explain its action briefly, suppose the fields are of unchanged polarity, and a source of direct current is inserted between the terminals A_1 and A_2, the armature will not turn but will vibrate to and fro through an arc covered by one segment of the collector, for its polarity will be constantly reversed as the brushes b_1 b_2 pass from one pair of segments to the next.

For the same reason, however, the polarity of the ring will remain unchanged if an alternating current be inserted between A_1 and A_2, for then the tendency to motion will be in one direction and the armature will soon attain a speed such that all the plus impulses will go through the odd numbered segments and direct connections to the winding, and all the negative impulses will go through the even numbered segments and reverse connections and the machine will be in synchronism. Under these conditions the successive opposite impulses of the alternating current supplied at A_1 and A_2 will all go through the ring winding in the same direction, say from top to bottom, though coming alternately from opposite brushes b_1 and b_2.

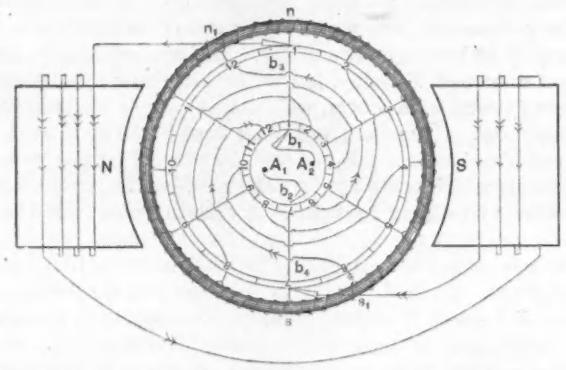
When this is the case, however, the brushes b_3 b_4 bearing on a collector connected to the ring in the ordinary way will deliver a current of one direction (rectified alternating, or pulsating direct current) to a shunt circuit which may be used for exciting the field.

At starting the current is not rectified for the fields, as this is only attained at synchronism, then the machine is affected by the alternating current precisely as a direct current motor would be under the same conditions of supply. The field and armature both reversing polarity at each reversal of current, the tendency to motion is always in the same direction. The machine starts and gains in speed until synchronism is reached, when the field receives a rectified current and the armature receives the current impulses all the same way, thus keeping its polarity constant. At this speed the machine will carry its maximum load without departing from synchronism, and evidently the synchronous speed of the motor may be very different from the speed of the dynamo, depending upon the number of segments in the collector of the motor armature as compared with the number of field poles in the dynamo. The synchronism of such machines I have found accurate to within less than one degree of arc.

At starting, the machine sparks considerably until synchronism is reached, which only requires a few seconds with 20 per cent. of the maximum load that it will carry when in synchronism. When this speed is reached the sparking decreases instantly and is no longer serious until the machine is overloaded, when it stops with violent sparking, but will instantly start up again on removing the load.

Here then is offered an excellent means of starting an ordinary alternating dynamo which it is desired shall be used as a motor on a single alternating current source of supply. Such a small motor having its armature secured to the spindle of the larger machine (dynamo to be used as motor) will not only start the latter, but it will start it with the same alternating current it is desired to use for the big machine; it will further indicate when the latter is in synchronism, so that the main operating current may be turned on to the large machine (driven dynamo) with safety, but it will hold the large machine at a uniform synchronous speed as long as desired, thus avoiding the necessity of catching the latter at the synchronous speed as it is passing from a higher to a lower speed.

The above seems to answer sufficiently the first and second statements contained in the above quotations, but the system proposed is capable of another and far more important step. Thus by a simple switching arrangement the field of the large motor may be placed in the circuit connected to the brushes b_3 b_4 of the starting machine which the motor will then drive as a dynamo, obtaining therefrom a uniform direct current which may be used for exciting the fields of both machines, thus avoiding all the difficulties incidental to the necessity of supplying the field of the large machine with a current obtained from a rectifying commutator carried on the large motor spindle. We thus have this simple relation of the two machines.



PATTEN'S SELF-STARTING ALTERNATING CURRENT MOTOR.

The separate exciter of the ordinary alternating dynamo becomes—when the latter is used as a motor—first its starter on the alternating current of supply only, then its synchronizer, and lastly its separate direct current exciter, which three functions are successively performed by the same machine without the use of extraneous mechanical devices of any kind for starting a direct current motor and giving to the large machine when started a field excited by a direct current of uniform E. M. F. from which a high degree of efficiency may be expected. If then the alternating dynamo used as a motor really meets the expectations of its friends as to efficiency and regulation they need have no concern about getting it started if they seriously wish to do so.

Another function of this machine will be briefly referred to here, as it concerns the more complex question suggested in the last of the quotations given above. With some modifications and changes of parts, the machine described may be used to transform a single alternating current into biphased or triphased currents of lower period than the original single alternating current, so that such a machine carried on the spindle of a rotary field or multiphase motor may be given the currents of differing phase it requires from a single alternating current used as a source of supply. The general plan of accomplishing this was outlined in a recent number of this paper and will not be referred to in detail here.

Early Transmission of Power Experiments with High Tension Transformers.

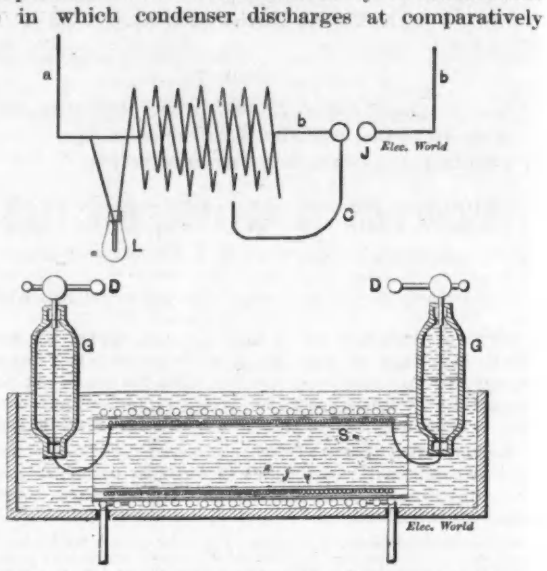
It may not be generally known that during the electrical exhibition of Turin, Italy, in 1884, there was in operation a transmission of power from that city to the city of Lanzo, a distance of 10 kilometres (6¼ miles). The wire was four millimetres in diameter, or about No. 6, B. & S. gauge. The alternate current dynamo generated 10,000 volts. At Lanzo the power was used to run 60 incandescent lamps of 16 c. p. and one arc lamp. At Lanzo there were four transformers of the Gaulard & Gibbs type, in addition to a special one for the arc lamp. On the 25th of September, in the presence of the International Jury, it was found that the efficiency was 89 per cent. Messrs. Gaulard & Gibbs were awarded the grand prize of 10,000 francs by the Italian government.

It is stated that this experiment led Prof. Ferraris to investigate the subject of secondary generators, which was then followed by his invention of the rotating field alternate current motor, for which he is now so well known.

Dynamic Induction at High Potentials and Frequencies.

BY ELIHU THOMSON.

It is the purpose of the present writing to supplement the experiments which were described by me a short time since in which condenser discharges at comparatively



FIGS. 1 AND 2.—APPARATUS FOR OBTAINING HIGH POTENTIAL DISCHARGES.

high potentials were used to induce by dynamic induction similar discharges in parallel circuits or coils.

The application of the principle to the production of an efficient lightning protector or device affording a selective path for high frequency discharges has already been pointed out. So also the effects of the use of varying numbers of turns in the coils under induction have been shown; effects which have enabled me up to the present to obtain sparks of over 31 inches in length in free air between ball terminals about one inch in diameter and in an apparently continuous stream of not less than 250 per second. These sparks are bluish white, like Leyden jar discharges, and are accompanied by a loud rattle or roar. These effects and their bearing on insulation will be further adverted to.

The following experiment is an exceedingly instructive one as showing the means I use for obtaining a balance of E. M. Fs. or selective path.

Two coils of heavy wire are wound, each having about 12 to 15 turns more or less. The coils are separated by a glass cylinder, one coil being in the interior of the cylinder and the other being wound outside thereof. Connections are made as in Fig. 1. The turns of the coils should be kept apart or well insulated from one another. An incandescent lamp, *L*, is put in circuit with one of the coils, as the outer one, by putting one terminal of the lamp in connection with one end of the inner coil and the other lamp terminal

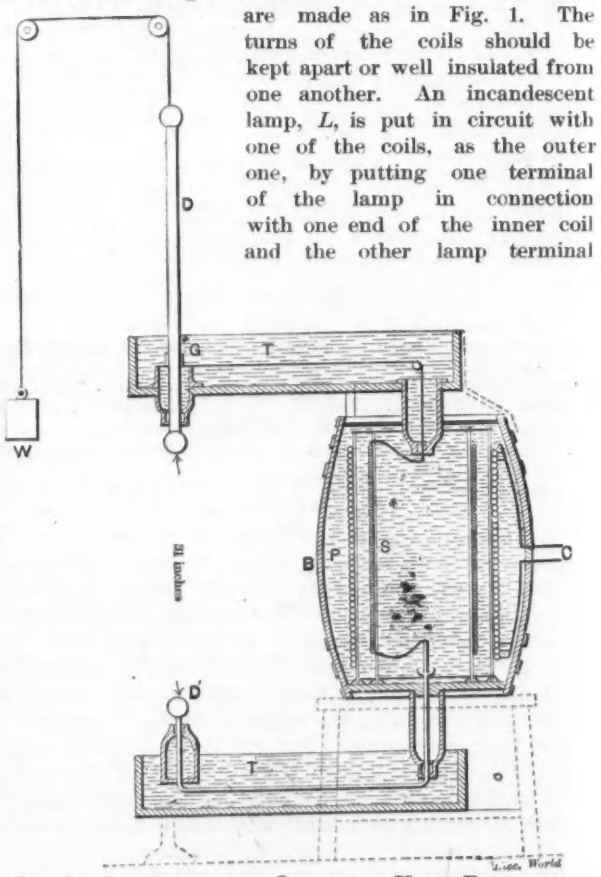


FIG. 3.—APPARATUS FOR OBTAINING HIGH POTENTIAL DISCHARGES.

to one end of the outer coil. The wires *a b* permit condenser discharges to be passed through the inner coil; a branch wire *C* is taken from *b*, and its free end can be connected to any part of the outer coil so as to include more or less of the turns of the outer coil in a branch with the lamp around the inner one. With, say, 12 turns in the inner coil, and a possible change of the turns of the outer coil from none to 15 or 16, and passing condenser discharges over an air gap at *J*, with an air blast playing on the spark to prevent continuous arcs when the condenser charges are furnished by the high potential secondary of an alternating current transformer, the lamp at *L* would be lighted to a greater or less brilliancy according to the turns of the outer

coil in use. In applying the movable wire to the outer coil at a certain point, there is found to be no current passing in the lamp, and on passing this wire either way from this point so as to include more or less of the outer turns, the lamp is lighted with a gradually increased brilliancy as the neutral point is more and more departed from. Of course a current indicator, provided it responds to currents of excessive frequency, may be substituted for the lamp. This experiment shows in the clearest manner the fact that a selective path for the discharges of high potentials is obtained in adjusting the relative number of turns in the outer and inner coils.

I have in a previous communication stated in what way this combination of inductive coils has been applied as a lightning arrester or protective apparatus for dynamos, motors, transformers, etc. Varying the spark length at *J* or the condenser capacity does not, so far as has yet been determined, disturb the relations found. It is, of course, necessary that the two coils be well insulated from each other, and this can easily be done by immersion in oil or separating them by glass, hard rubber, or the like.

I will now describe certain forms of apparatus which are adapted for obtaining at will very high potential discharges. In fact, I have been able easily to obtain from about 1,600 feet of wire sparks of over 31 inches between the discharge balls (see Fig. 5). So far as can be estimated from available data, these sparks are due to potentials of not less than half a million volts.

In Fig. 3 (see also Fig. 4), *B* is a barrel of lubricating oil, an oil of high insulating qualities, being in fact a liquid paraffine. The top of *B* is open, and in it are immersed the primary and secondary coils *P* and *S*, each wound on a paper cylinder.

The cylinder on which *S* is wound is about three inches smaller in diameter than the other, and has an external diameter of about 13 inches. It is covered with two layers of silk, and upon this is wound 500 turns of No. 26 cotton covered wire in one layer, with a silk thread between the turns. This layer covers about 20 inches of the length of the cylinder. The terminals of this fine coil are carried out respectively through the lower head and up through the oil above, as will be described.

The primary *P* consists of 15 turns of a conductor composed of five rather heavy wires laid alongside, and the connections are made by carrying the terminals outside at *C*, keeping them about two inches apart. The wire leaving *S* downward goes to a rod which rests in a cup in the centre of the bottom head of the barrel. This cup has a rod extending down through a glass cylinder filled with oil which dips in a horizontal trough of oil T^1 through the centre of which is carried a prolongation of this rod to conduct the discharges to the lower discharge terminal D^1.

The upper end of *S* is treated in a similar way, passing up through a cork in a glass vessel, such as an inverted bottle with the bottom perforated, then horizontally in the trough *T* of oil to the sleeve *G* through which a hollow brass *D* with rounded ends may be slid up or down. For this purpose a string and pulley with counterweight *W* may be provided. The bar *D* should be, say, an inch in diameter, to avoid brush discharges from its sides, and, in fact, its upper end should be covered with a bottle of oil or have a large polished ball, otherwise large brush discharges will pass into the air from it. By means of a condenser connected with the primary *P* and spark gap, with a blast of air blowing across the gap, the apparatus may be used to obtain the high potential and high frequency sparks. The charging of this condenser is from the secondary of a high potential induction coil giving about 15,000 to 20,000 volts, the primary of which coil is fed from alternating current mains. The condenser used in the experiments consisted of 16 Leyden jars of about a gallon each, which was all there was at command. This will be replaced by a special condenser adapted for such work. The discharges from the apparatus are, as stated, over 31 inches long, and this distance is the maximum that can be given to the space between the terminals as the apparatus is constructed.

The power of the discharge is exemplified by the ease with which glass plates are punctured. Heavy pine or even oak boards are perforated and set on fire. The discharges scorch a black line where they pass over a surface of wood, and soften glass where they locate themselves in passing over sheets. A stick of wood placed between the terminals and joining them is splintered and torn by the discharge, and is found covered with a fur of fine splinters. Glass vessels are shattered in the line of the discharges and inflammable matter is set on fire.

Perhaps the most beautiful effect is obtained by the insertion of a plate of glass between the electrodes when separated about twenty-four inches. If the glass be thick enough to resist perforation, the discharges spread all over it and pass around the edges, producing an almost indescribably beautiful effect, especially in a feebly lighted room, which allows all the minor ramifications of the spark to be seen.

The induction in the fine secondary of the apparatus is about 1,500 to 2,000 volts for each turn, which would give 750,000 to 1,000,000 volts total for the 500 turns. But on account of condenser actions absorbing a part of the discharge, it is probable that the effective electromotive force between terminals may not much exceed 500,000. We have no ready means of measurement of such pressures.

A very simple and inexpensive form of apparatus for obtaining these high potential discharges is shown in Fig. 2.

It consists of a wooden trough, the joints of which are capable of holding oil. Its parts may be nailed or screwed together in the ordinary way with shellac or white lead.

The primary coil of ten turns lies against the sides of this trough, and the secondary layer may be an ordinary wire heavily insulated with cotton and wound on a cylinder *S* of paper or card board covered with dry muslin or silk. If the turns are not over six inches in diameter the cotton insulation between the turns will suffice if rather thick, say $\frac{1}{100}$ of an inch or over. The primary must be connected with a condenser and a spark gap, as usual, the condenser being charged from the secondary of a high potential induction coil.

The secondary terminals are taken out at the centre of the ends of the cylinder, as shown, and led up through a glass vessel *G*, which may be conveniently made of two bottles with the bottoms removed and cemented together, or a specially blown glass vessel may be used instead. Its object is to hold oil and cover the secondary terminals to a height sufficient to remove them far enough to prevent discharges passing over the surface of the oil in the trough, which is used to cover the coils, as indicated. The discharge terminals *D D* pass up and outward from the bottles and the sparks are obtained between them. The simplicity of construcion is evident; a trough four feet long will hold a coil capable of giving a spark discharge three feet long. By coupling up two such troughs in tension this effect may doubtless be doubled if required.

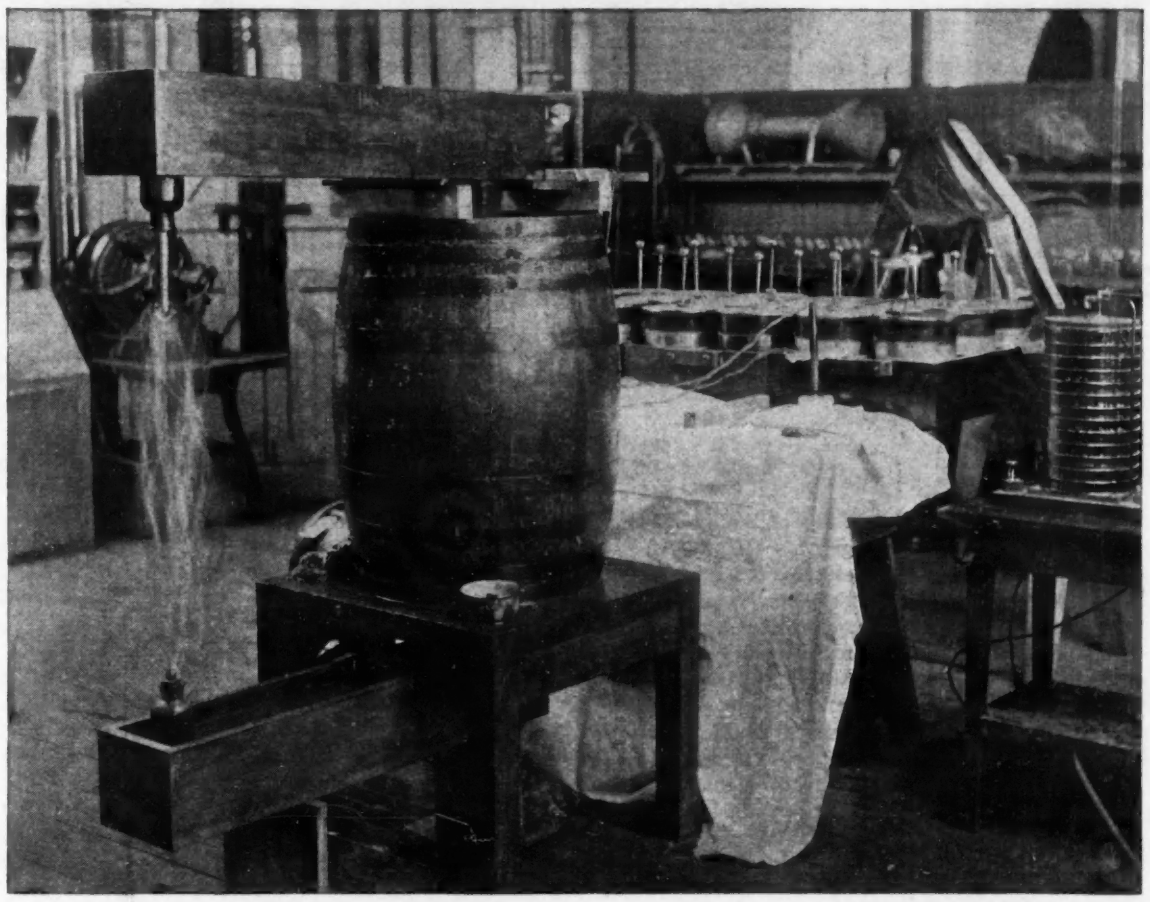


FIG. 4.—GENERAL VIEW OF APPARATUS, SHOWING THE INDUCTION COIL.

It is important, of course, that all connections, leads from the condenser to the primary coil, etc., be as short and as free from self induction as possible, or the rate of oscillations, on which the high inductions depend, will be lessened, and the effects be weakened to some extent. The potential given by a secondary coil of a certain number of turns depends, of course, on the rapidity of magnetic change and the extent of such change, or maximum densities of field attained. The greater the number of turns in the primary the greater will be the field strength if the same current flows in every case. But increasing the number of primary turns slows the oscillation rate and diminishes the maximum current value and so diminishes the magnetic density. There is evidently to be selected, therefore, for each condenser, that number of turns which will give the highest product of the rate of change and the extent of change or maximum field.

As a striking illustration of the slowing effect of numerous turns of wire on the periodicity or rate of change, it may be mentioned that if, instead of passing the condenser discharges through a coarse coil of few turns, using the spark gap and charging transformer as before, they be passed through a well insulated coil of many turns of comparatively fine wire, the discharge rate may easily be brought down low enough to cause the spark to whistle along with the sound of the alternating discharges of 125 periodicity used in the charging transformer. The introduction of a well made iron wire core greatly lowers the tone obtained. It is conceivable that an approximation to music might be obtained from spark discharges sent through coils of such varied inductance as to cause the rates of oscillation to follow those of the musical scale.

In the conduct of the experiments on high inductions, which have been described, one cannot fail to be impressed

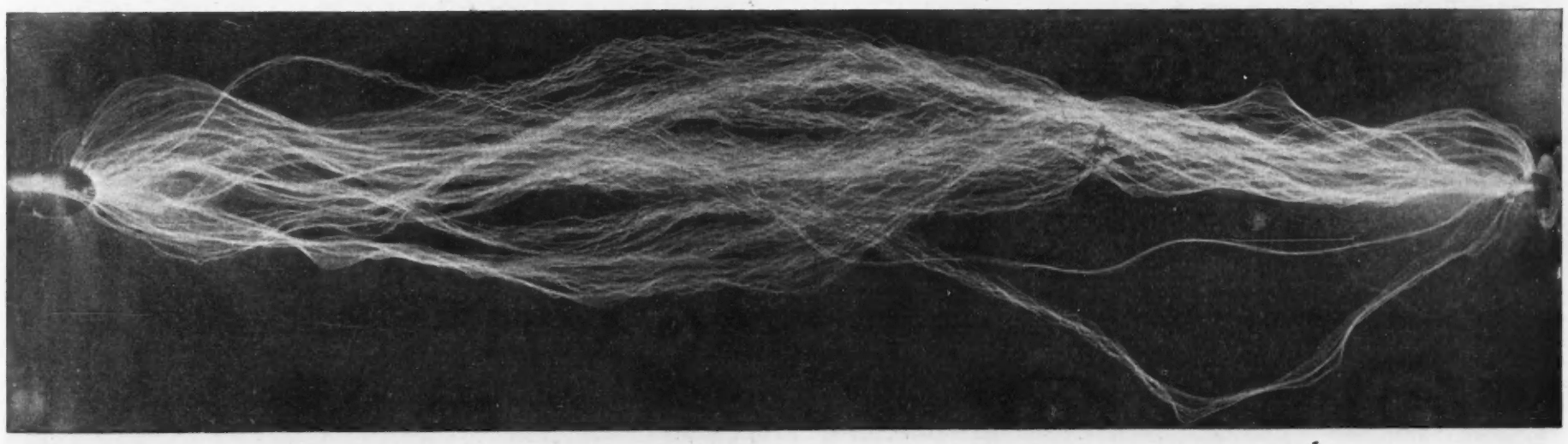
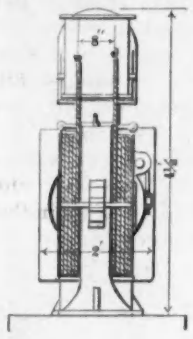


FIG. 5.—DISCHARGES 31 INCHES IN LENGTH AT PROBABLY 500,000 VOLTS, PHOTOGRAPHED BY SIX EXPOSURES; TOTAL TIME, 1 1-2 SECONDS.

with the capabilities of oil as an insulator. The perforation of two inches of oil between rounded terminals of, say one-half inch diameter, would seem to demand a potential capable of causing a leap of five feet in air. It appears to be true that edges or points under oil or embedded in any insulating medium are effective in inducing puncture for the same reasons as they are effective in discharging through air. They act as electric wedges and concentrate the dielectric strains upon those parts of the insulating medium directly in front of such points or edges. Hence, the most perfect insulation to resist puncture in oil or air demands smooth surfaces of as large diameter as possible. This is of course a different matter from insulation resistance or power of resisting leakage.

The Sprague-Pratt Electric Elevator.

In considering the application of electricity to the operation of passenger elevators it is well to remember that there are two classes of passenger elevator service, each distinct from the other, and each requiring a distinct type of elevator construction. The first class has been developed by the increased height of buildings, which has demanded a service of high speed and smooth motion regardless of the cost of the apparatus, the space occupied, or the cost of operation. The hydraulic elevator, a development of the last 10 years, is the result of this demand, and is the only one that has up to the present time been accepted for this service. The second class of elevator work is that which requires a speed from 150 to 225 feet per minute. This applies to small apartment and private houses, and other buildings of four or five stories where only light elevator duty is required. This class of service is supplied by worm gear elevators, which are now becoming popular in an electric form. The worm gear elevator was discarded for high speed service over 10 years ago, or as soon as the hydraulic method of operation made it possible to attain 300 feet per minute, or even more.



An entirely new method of operating elevators by electric power has been utilized in the construction of the Sprague-Pratt electric elevator, the joint invention of Mr. Frank J. Sprague, well known for his energetic and persistent work in the development of his electric traction system, and Mr. Charles R. Pratt, an elevator engineer of ability and experience. In the design and construction of this elevator an attempt has been made to secure unlimited speed at an absolutely smooth motion, with economy of space, operation and safety, as the specific conditions of passenger elevator service. It will be seen that the first of these is a condition inherent to the general principle of the machine, since the transmission of power developed by the revolving armature of the electric motor is communicated direct by means of a nut and screw to precisely such multiplying sheaves as are usually driven by the piston of a hydraulic elevator cylinder. The substitution of a nut and screw for the hydraulic cylinder, the attachment of the nut to the cross-head of the traveling sheaves, and the revolution of the screw by means of an electric motor, form the fundamental principle of the Sprague-Pratt elevator. The designers having satisfied themselves that the multiplying sheaves of the hydraulic elevator were the best means of communicating a perfectly smooth high speed motion to the car, it was determined to operate these sheaves without the expensive complications of a hydraulic plant, without vibration and with perfect safety, by means of a nut and screw. It was also determined that to obtain the perfectly even acceleration of the speed at which the screw must be revolved, and to obtain perfect control over it, the electric motor was peculiarly adapted.

Take, for example, an elevator of eight multiplying sheaves, the traveling sheave carriage will move one-eighth as fast as the car; assume the pitch of screw to be 1 inch, then for every revolution of the motor the car will rise 8 inches, and 450 revolutions per minute of the motor will give a speed of 300 feet per minute to the car. Suppose the elevator to have 12 multiplying sheaves, and the pitch of the screw to be $1\frac{1}{4}$ inches, then for every revolution of the motor the car will rise $1\frac{1}{2}$ feet, and 600 revolutions per minute will give a car speed of 900 feet per minute. This range of speeds covers any demands for high-speed service, and is safely within the capacity of this elevator, which is capable of adjustment to any speed between these limits.

The refinement of control can be appreciated when it is understood that the speed of one of these elevators now running can be varied by the car switch, from half a foot to 400 feet per minute. The car switch operates a small motor located at the hoisting machine. This motor in turn operates a switch which regulates the speed of the hoisting motor, and also operates a brake to hold the screw when at rest. The wires connecting the car switch with the controlling motor are laid in a practically indestructible cable composed of two flat rubber belts, vulcanized together with the copper wires in between. This forms a double rubber belt such as is used to drive shafting, and as in this service it only has to follow the car by being secured to a point half way up the hoistway and from there leading down and up to the car by a loop four feet in diameter, its durability must be a matter of years.

Although the operator in the car can accelerate the speed and decrease it as slowly as he wishes, it is impossible for him to start the car suddenly; the controlling motor takes a fixed time to start or stop the car, which time is set to the shortest limit that is consistent with comfort to the passengers.

The Sprague-Pratt elevator occupies only from one-tenth to one-third the space required by a hydraulic plant of equal capacity. The floor space which the elevator will occupy may be estimated as follows: Measure the distance in feet that the car travels, divide it by 10 and to that add 13 feet. This gives the length of the elevator machinery over all. Allow 2 feet for its width the entire length (it is 2 feet wide for only 4 feet of its length and $1\frac{1}{2}$ feet wide the rest of the distance, except for very heavy loads, when it would be 2 feet wide the entire length) and 3 feet 6 inches for its height. This gives approximately the space required for this elevator. It can be located anywhere that it is possible to lead the ropes from it to the car over proper sheaves.

The economy of operation in the Sprague-Pratt elevator is self-evident. In comparison with a hydraulic plant of equal capacity it costs only about half as much for power, requires less attendance, occupies less space and permits the entire steam plant of the building to be shut down either for repairs or if there should be no use for it during the summer months. The total efficiency claimed for this elevator is 60 per cent.

The greatest care has been taken to secure the maximum conditions of safety. The screw is a bar of special forged steel, and is capable of sustaining 20 times the heaviest load that can be applied to it. There are two separate nuts, one of which transforms the revolutions of the screw into a straight line motion of the traveling multiplying sheaves. This is called the hoisting nut. It engages 12 of the screw's threads, or, more strictly speaking, 12 convolutions of the screw's thread, and between its thread and the screw thread there are 250 half-inch hard steel balls. These balls place the transmission of power between the nut and screw upon purely rolling friction; no part of the nut touches the screw, and the balls are circulated from end to end of the nut by a tube, each end of which enters the ball way between the threads of the nut and screw. As the balls emerge from one end of the nut they enter this tube, which returns them to the other end of nut, where they re-enter the ball way. The introduction of rolling friction at a nut and screw is the secret of the high efficiency of this elevator, every part of which in the line of transmission of power from the motor to the car is also on rolling friction. For example, the thrust of the screw is on ball bear-

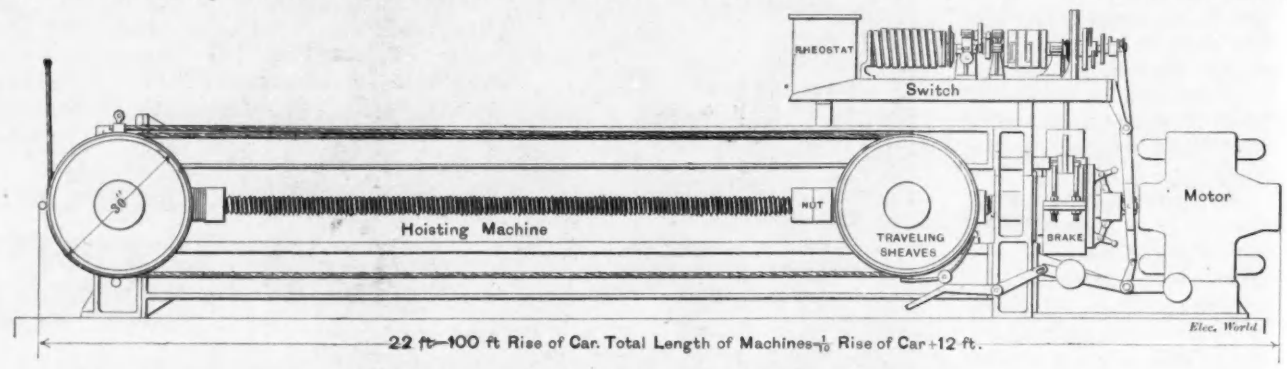


FIG. 1.—SOME DETAILS OF THE SPRAGUE-PRATT ELECTRIC ELEVATOR.

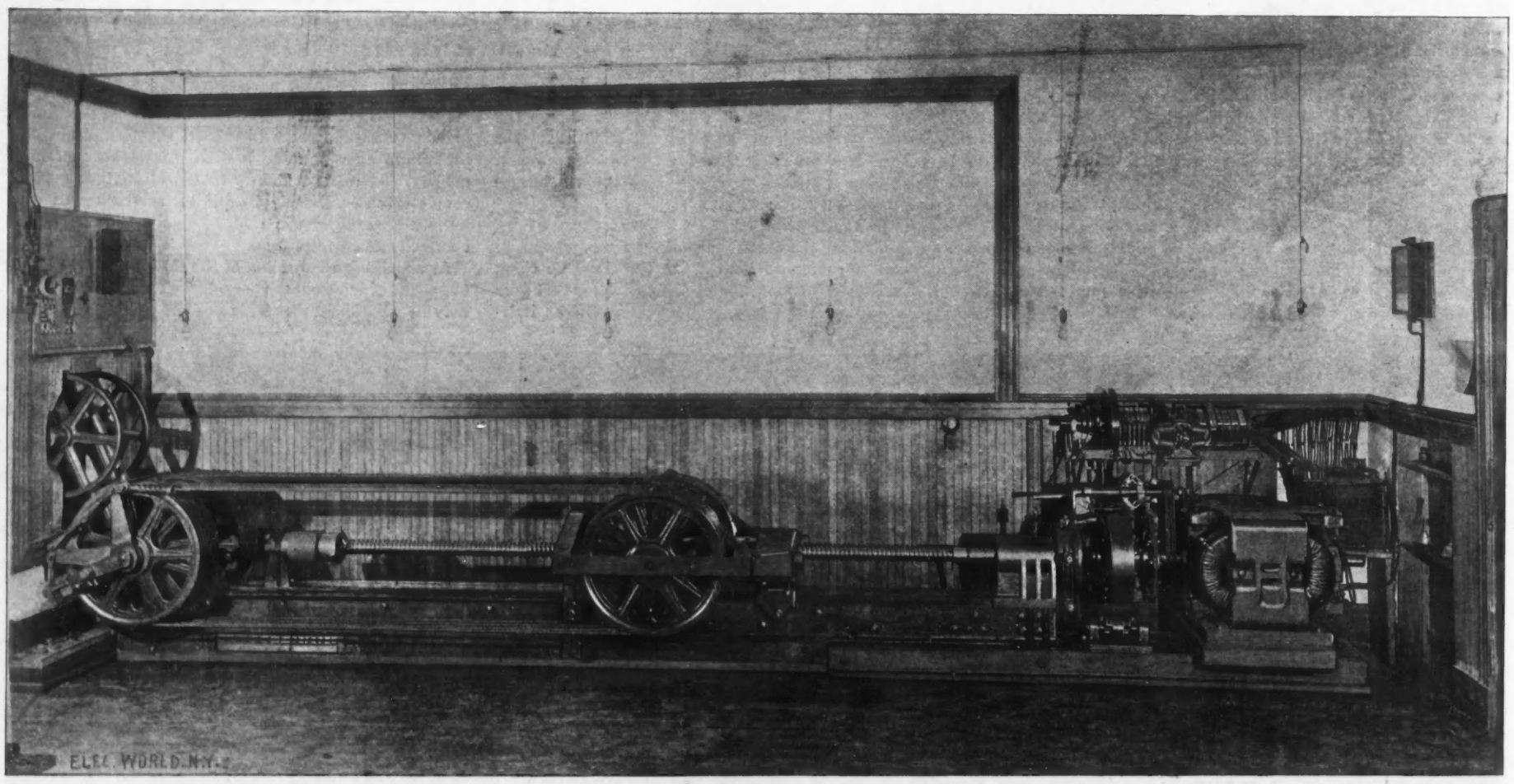


FIG. 2.—GENERAL VIEW OF THE SPRAGUE-PRATT ELECTRIC ELEVATOR.

ings, and the multiplying sheaves are on hard steel ball bearings, which, with the ball nut, complete the transmission of power upon rolling friction.

The other nut, which is called the safety nut, is normally out of contact with the screw's thread; it is secured to the hoisting nut, and should any accident happen to the latter which would break its hold on the screw's thread, this safety nut, the thread of which interlocks with the screw's thread to a greater depth than the thread of the hoisting nut, would then take the place of the hoisting nut and form an anchorage to hold the traveling sheaves with a grip exceeding the strength of the screw. This would put the elevator out of operation, as the friction between this nut and the screw is greater than the friction caused by the pressure of the traveling sheave crosshead against it. This nut would then act simply as a collar on the screw, and revolving the screw would then transmit no motion to the car.

Fig. 2 shows one of the first elevators built on this principle, and which is now in operation in an office building on Twenty-third street, in this city. The standard type, which will be manufactured by the Sprague Electric Elevator Company, of 15 Wall street, will be of a slightly modified construction as regards the base of the machine and the motor used, but the general principle of operation will be the same. Fig. 1 shows some of the details of construction. The ball bearing nut used on this elevator was illustrated in THE ELECTRICAL WORLD of Nov. 1, 1890.

A Watchman's Time Detector.

The accompanying illustrations show a watchman's time detector in which the principles of the hour glass have

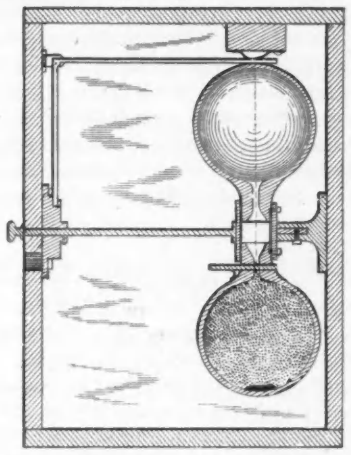


FIG. 1.—A WATCHMAN'S TIME DETECTOR.

been employed in a very interesting way. Fig. 1 is a vertical section of the instrument and Fig. 2 is a general view.

The main idea is that the sand in the hour glass is to run out in exactly one hour and at the end of an hour it registers 1 on the dial. The watchman's duty, then, is to make his hourly visit and reverse the glass, which is done by means of a handle. The sand will then run again for one hour; at the end of that time it will register again on the dial, this time No. 2. If the watchman is on duty 12 hours he must show No. 12 registered on the dial when he goes off duty. To do this he must turn the hour glass once an hour, and if he neglects to do so the dial will not register, and it will be clearly shown how many times he has failed to visit the station. The hour glass is divided, having a dial between its parts. It is impossible for the watchman to turn it except at the end of the hour, as it is locked. There is an auxiliary device for changing the length of time in which the sand will run out so that the instrument may be used in places where the watchman is required to make visits oftener than once an hour.

This apparatus forms what is called the central station of the system; from each sub-station a wire is run direct to the hour glass, in the circuit of which a push button is placed. On the instrument is placed a wheel with as many teeth as there are sub-stations, so arranged that the hour glass cannot be reversed unless each station has been visited. This forms a second check on the watchman's accuracy, since every button must be pushed in order to make the wheel turn and complete the revolution, as it must do before the glass can be reversed. In this way each station, as well as the hour glass itself, requires an hourly visit. The inventor of this instrument is Mr. W. D. Hawley, of Syracuse, N. Y.

A REVOLVING FAN MOTOR.

A Revolving Fan Motor.

The accompanying illustration shows a Crocker-Wheeler fan motor mounted upon a suitable stand in such a way that when in operation it revolves about a vertical axis through the centre of the machine. The current is supplied to the revolving machine through the two brushes shown bearing upon the rings at its base.

The motor is mounted in such a manner that it keeps slowly revolving about its vertical axis so as to direct the current of air created by the fan in all directions from the position of the machine as a centre.

Electric Lighting of Vehicles.

The present method of interior and exterior lighting of vehicles is attended with many objectionable features, aside from the inherent shortcomings of the primitive candle and kerosene lamp. The many advantages of the incandescent lamp for this purpose have stimulated inventors to provide means for using these lamps where direct current is not available. An example of this kind is shown in our illustration, where the incandescent lamp is applied in a manner that combines all of its good features.

A specially designed incandescent lamp is suspended on springs in front of a silver plated reflector. This is enclosed by a beveled plate glass mounted in a brass rim that screws on the reflector, thus preventing any injury to the lamp. This compact arrangement requires a space of but three and one-half inches in diameter and projects less than three-fourths of an inch from the top of the carriage. Lamps mounted in the same way or in small sockets are placed in the outside lanterns. A switch is located at a convenient point in the carriage to light or extinguish the lamp, and an additional switch may be placed within reach of the driver for the outside lamps.

A case containing a few storage batteries is placed under the driver's seat or inside the carriage. A small flexible cable is run from the batteries, preferably under the lining, to the points where the lights are required. The batteries are connected to the two handle supports which act as terminals for charging or discharging. These batteries will run lamps equal to six candle power for ten hours. The weight of the entire equipment is 30 pounds.

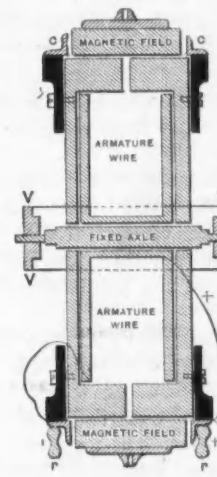
The batteries may be charged by direct current or primary batteries. The Storage Battery Supply Company, whose portable electric lantern was recently illustrated in our columns, is manufacturing these outfits.

Cazal's Gearless Electric Railroad Motor of 1864.

In a recent issue of *L'Industrie Electrique* Mr. A. M. Tanner describes a gearless motor for electric railroads patented by a Frenchman, Jean Henri Cazal, who took out his French patent May 25, 1864, No. 63,155, entitled "Electro-Magnetic and Magneto-Electric Apparatus, Fixed and Locomobile Motors." The fundamental patent of George F. Green, recently described in our columns, was what prompted Mr. Tanner to look up this old record in order to see if the claims of Green are valid.

The motor is shown in the adjoining cut, though without a number of details, which, however, are described in some of the other views in that patent.

r r represent the rails, which are used to convey the current, *c c* are the wheels, which, as will be seen, are connected to the motor by means of some insulating material. The axle is fixed and to it the armature of the motor.



CAZAL'S GEARLESS ELECTRIC RAILROAD MOTOR.

The nature of the motor is not sufficiently described in Mr. Tanner's abstract to be clearly understood. It appears, however, to be on the style of the early motors, consisting of magnets attracting iron armatures, the currents to the magnets being led through the commutator at the proper moments. Those who are interested are recommended to look up the original patent.

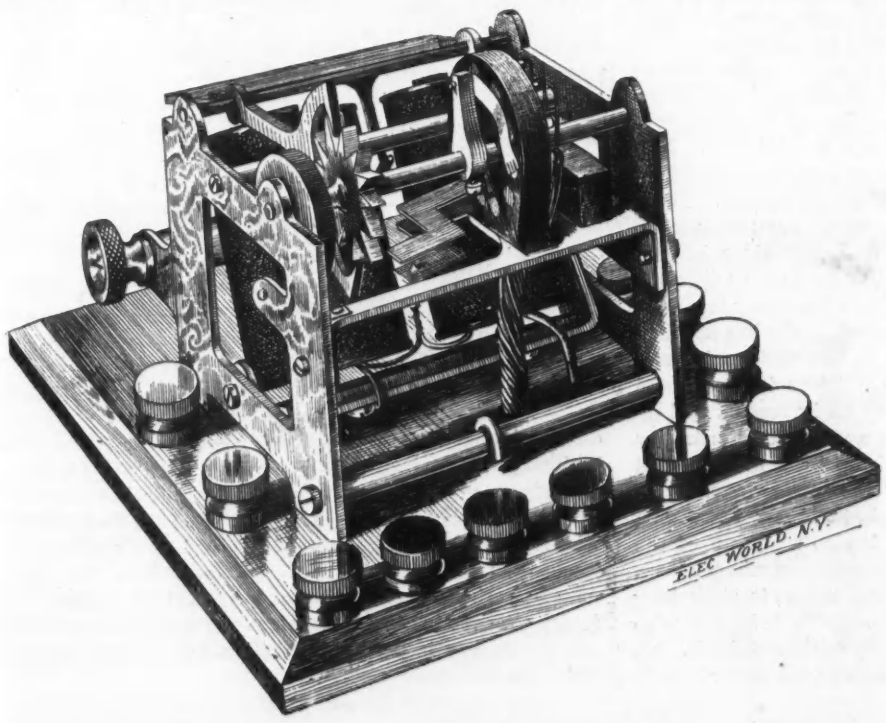


FIG. 2.—A WATCHMAN'S TIME DETECTOR.

ELECTRIC LIGHTING OF VEHICLES.

It is interesting to note that the inventor appreciated fully the advantages of electrical traction, as he speaks of the saving dead weight in the usual steam locomotive and other features. He mentions the fact that electric locomotion is especially well applicable to mountain regions, where the water power of the streams in the valleys could be used to great advantage. He also suggests using the wind in these mountain districts to drive windmills, which in turn are to drive the generators.

Particular attention is called to the fact that the rails are used as the conductors of the current.

Track Bonding and Overhead Railway Construction.

BY JAY WILEY.

Now that the unaccountable enmity to the harmless trolley is dying out, and cities are more liberal in granting franchises to electrically equipped roads, there will be a number of street railroads that will take advantage of this, their long sought opportunity, and adopt "juice" as their motive power this spring. The station and cars are usually equipped by the electric company of whom the apparatus is bought, and the track bonding and overhead construction is usually done by the railroad company. This being the case, there will, very likely, be a number of street railroad men, who, though inexperienced in electrical matters, will have the supervision of such work on their hands. The following points are submitted in the hope that they may be of use to those placed in such a position.

The track bonding requires care, but no experience to speak of. Sweat into holes drilled in the web at each end of each rail, with the channel pin, a No. 6 soft drawn tinned copper wire, the ends of which are soldered to a No. 0 wire, of the same material, laid between the rails. Have the holes in the rails a thirty-second of an inch greater in diameter than the channel pin. Bend over the end of the No. 6 wire, after it has been sweated in, up close to the rail. Where possible, have the rails drilled before being laid, and do the soldering with a soldering pot and ladle. At places near the road, where there is wet ground or a river, by sinking a couple of car wheels and running a wire from them to a supplementary wire between the rails, the efficiency of the road may be raised.

Too much stress cannot be laid on the importance of taking great care with all connections, obviating as much as possible the danger of their jarring loose or becoming disconnected. Overhead construction is more complicated, and if not requiring more care, requires more experience to do properly than bonding.

First mark the points at which holes are to be dug for poles, which, in double track construction, will be 110 to 120 feet apart, and when on streets that have a curb can easily be kept in line by setting just inside of the same; but on suburban lines the points should be kept in line by a surveyor's transit.

Nothing is more unsightly, or more disastrous to the proper suspension of the trolley wire, than having the poles set zigzag fashion. Poles, if of wood, should be of cedar, chestnut or Georgia pine, smoothed and turned up to present a good appearance, and pointed. Have the butts painted with asphaltum. Length, 28 feet; diameter of top, 7 inches; bottoms, 10 inches. Dimensions of iron poles: Length, 28 feet; diameter of sections, 6, 5 and 4 inches. Curve poles should have a diameter of sections of 7, 6 and 5 inches, respectively, and a length of 30 feet. Iron poles are preferable, and should have iron trimmings and an insulated cap. Dig pole holes of sufficient diameter to allow room for tamping and a filling of half a barrel of cement and about the same quantity of cracked stone. The correct depth of pole holes can be gotten to a nicety in the following manner: Make a tripod that will span the track, and stand firmly when resting on the rails. (See Fig. 1.) Have a spirit level fastened to it, so that when the tripod is spanning the track the level will rest lengthwise

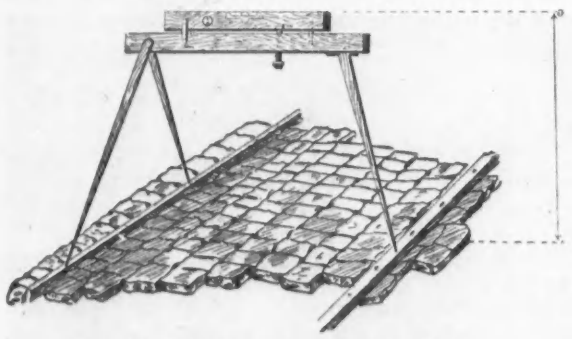


Fig. 1.—Transit for Planting Poles.

at right angles to the same. Have it fastened, also, in such a manner that it can be brought to a level, at whatever angle the tripod may be standing when in position. Let the tripod be of such a height that, when in position, the distance from the level of the track to the top of the level will be 5 feet. Cut a stick that measures 11 feet 6 inches. Dig a hole to such a depth that when one end of the stick touches the bottom of the hole the other end can just be seen when sighting over the top of the level standing on the track. This plan will give a height of pole above the level of the track of 21 feet 6 inches, and set it (provided the ground is level with the track) 6 feet 6 inches in the ground. This plan will be found a great convenience, especially on suburban sections of a road, where the ground in which the pole is set varies from a level to a foot or two above or below the level of the track. Getting the pole holes a correct depth at first, obviates the possibility of having to dig deeper after the pole is thrown in, which is an exceedingly unhandy piece of work. By making a chalk mark on the pole 16 feet 6 inches from the top, and bringing this mark on line with the level on the track, the pole will be just the correct distance in the ground and out. Give the poles a rake of about 1 foot in 25 feet.

By fastening a spirit level at this angle to a piece of light board that is a true rectangle (see Fig. 2), having a length of about that of the level, placing the edge of the board against the side of the pole, and bringing the level to a true perpendicular, the pole will have its correct rake.

While being held in this position, any slight distance it may be out of line, caused by the imperfect digging of the hole, can be remedied by lining it up with those previously set. Then by keeping the raking level at a true perpendicular while placing some heavy stones fore and aft of the pole at the bottom of the hole, filling in and tamping thoroughly, a half barrel of cement freshly mixed with water and cracked stone about the size of nut coal, the pole will be firmly set, just the proper distance in the ground and out, at just the right rake and in line with the others, the result being, if care is taken, that one pole will be as nearly like another as it is possible to get it. The poles being the foundation of the work, it follows that they should be set with care, and in the best manner possible. Do not let the linemen follow the pole setters too closely. The cement should have a day or a day and a half to set, according to the dampness of the ground, before any strain is put on the pole.

The best span wire is that which is made up of two or more wires twisted together into a cable. A cable makes a neater span than one of equal strength consisting of a solid wire, is less liable to break and is more easily handled.

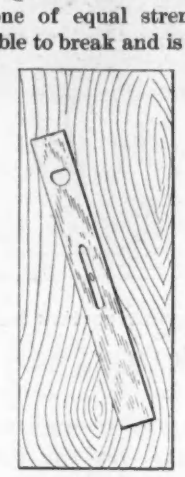


Fig. 2.—Rake Level for Poles Level at an Angle of 2½ Degrees.

Two No. 6 wiped Swedish galvanized iron wires, twisted together, combine neatness with strength, and are easily handled. The twisting of the two wires can be easily accomplished by cutting two wires a little longer than double the length of one span (say 125 feet when running on streets 60 feet wide), fastening two of the ends to a common point and the other two ends to the diametrically opposite spokes of a wheel (an idle buggy or cart is convenient for this), pulling very near taut, and revolving the wheel, keeping a man midway of the span to see that the wires twist symmetrically.

In fastening spans to iron poles use a good pole insulator and iron collar clamped around the pole with a bolt. The iron collar is preferable to a stationary fastening on the pole, as it enables the height of the trolley to be regulated at will. By using a hanger that clamps on to the span wire, instead of one that ties in and forms part of the span, the cost of two turnbuckles per span can be saved. Then when the trolley is out of line shift the hanger instead of shifting the whole span with the turnbuckles. Where turnbuckles are not used, tie in one end of the span to one pole, use a tackle on the other end on the opposite pole to haul up quite taut while tying in, then, when the tackle is removed, the spring of the poles will bring the span taut before any strain is put on it. It is best to insulate all spans, guys and anchors at the pole, in addition to the insulations at the ear or hanger. There are two sizes and kinds of trolley wire in common use today—No. 0 hard drawn copper and No. 4 silicon bronze. The former is advocated because it does not cut into the trolley wheel so rapidly, and it is not necessary to run as many feeders to equalize the potential on the line as when the latter is used. Mount the reel of the trolley wire on a rack that permits it to turn freely. Place it in a wagon and arrange a powerful brake that can be applied and released quickly. Make a temporary anchor for the trolley on the end pole or on a tree. Start the team with the reel paying out the wire, follow it by the tower wagon, with the wire running up and over the tower. Have two men in the tower and a quantity of S hooks, made up of the ends of the span wire. As the tower wagon moves along, with the wire running up over the tower, it stops long enough under each span for one man to raise the wire while the other hooks it to the span with an S hook. To do this requires but a few seconds, and the tower should have no difficulty in keeping up with the reel. The rapidity with which the wire can be strung in this manner, by a few live men, is surprising to a novice. The object of the brake is to keep it from racing and to stop it while the team keeps moving to haul up when there is too much slack let out. Upon striking a curve run the reel past the same, bring up the tower, pull the wire over about the centre of track all around curve, keeping it in place by temporary guys, run out from the curve poles and twisted around the trolley, keeping those run at an angle from slipping by fastening clamps to the trolley. Five or six temporary pull-offs per curve will usually be found all that are necessary.

On reaching the end of a section, haul up with a tackle, until there is a sag of about 12 inches to 15 inches in the trolley wire between the spans. This will not be too much in summer, and in winter it will be slack enough to permit a well tensioned trolley to bend it sufficiently to crack the ice and sleet on it. Use a hanger that fastens on the span in such a manner that it can be shifted on the wire. Suspend a plumb-bob from the trolley at each span, and shift the hanger until it is exactly centered over the track. Let the object be, in making a curve, to get a good curve with as few points as possible. From five to eight points, including body spans, will usually be found all that is necessary to obtain this object. Divide the distance between the points about equally, varying it, of course, according to circumstances, as it will often be found that a better curve can be obtained by bringing some points close together and putting others farther apart. Properly locating the points on a new curve, at first sight, is accomplished only by an experienced eye, and he who lacks this experience will often find it necessary to change the location of some of his points, even after the curve is completed, in order to obtain the best results. Keep the trolley as nearly as possible about ten inches inside of the inside rail all around the curve.

The two spans next to the curve on each side should have soldered ears instead of hangers, as well as the joints on the curve. Having located the joints, clean the wire thoroughly the length of the ear to be soldered on, acid it, as well as the ear, which has first been tinned. Hold the ear close up under the wire, run the irons (see Fig. 3) back and forth over the wire, melting the solder so that it will run down and fill up the ear. As soon as it is full, turn it over quickly, and clamp it very tightly to the wire at three or four points along the ear, with pipe tongs, while both wire and ear are being wiped smooth and clean with damp waste. Be sure the ear is full of solder before turning it over, and examine it closely the whole length of the ear, and if there is any point where the solder has not caught it should be removed and tried again. It is quite a nice piece of work to solder on an ear properly, and it is important that it should be done so. Strain ears should be deeper than the ordinary; should almost completely encircle the wire. In soldering these ears on, it is best not to turn them over, as they hold so much solder that it will spill if turned over when hot.

In order that it may be in its proper position when cold turn the wire half over, and hold it while the ear is being soldered, then when cold, release it; the spring in the wire will then bring the ear where it is wanted. After ears have been soldered at joints on the curves, attach the insulator and body hanger, tie in the guy at the curve pole (let them be of ample length), run each guy out to its respective point, put the clamp on the guy, and a rope around the trolley, attaching the tackle thereto, haul it up till the plumb-bob, suspended from the trolley, hangs about 10½ inches inside of the inside rail. Hold it in this position until the guy is tied into the body hanger, when the tackle can be removed; and so on from point to point around the curve. Wherever hot irons are used on the trolley wire, do not let them rest too long in one place, nor heat the wire excessively, as heat tends to crystallize the copper, thereby reducing its tensile strength. The line should be anchored both ways, on each side of every curve, to protect the same, and about every mile or three-quarters of a mile, on a straight line. In tapping in the feeders, run an insulated wire from feeder to feeder ear on the line, binding it to the span wire with tape. On a double track line, running a wire from the other remaining binding post of the first feeder ear over to second is easier than running a continuous wire from a feeder to a second feeder ear, and tapping in for the first one.

Fig. 3.—Soldering Iron.

The practice of using an insulated hanger or ear on a line where feeders are to be tapped in, and conducting the "juice" to the line by the span wire, is not to be commended. Set the switches far enough back from the track switch so that the car will take its switch and start to turn before the trolley reaches the line switch. Let the trolley wire of the curve overlap a foot or two where it strikes the straight line wire; thus enabling the switch to be moved until it is properly located. By curling this up neatly on the top of the switch, it will be convenient in case it is needed, and cannot be seen from the street. Make a permanent anchor at the ends of the road, by using a cable consisting of four or six of the iron wires used for spans, hauled very taut, and spanned across the track just where it terminates. Haul the trolley up and tie it into this cable, then use strain ears at the span next to this, and

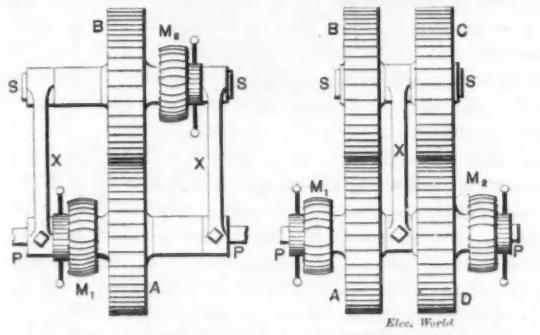
run from them a heavy cable to the poles to which the span cable is attached. It is best to give the poles by which cables are suspended a little more rake, and have them heavier than the ordinary. In anchoring the ends of the lines in this manner, the overhead work terminates just where the track does, which is an advantage over anchoring to poles set some distance beyond the track, for, by reducing, when possible, the number of overhead wires and supports, it reduces the ground for complaint against the system. To combine stability with neatness should be the object of every lineman. The public have opposed the overhead trolley system on the grounds that it was dangerous to human life, and spoiled the beauty of streets by its unsightliness. The first objection has been eradicated by innumerable tests and proofs to the contrary, but the latter still holds good in a great number of cases. That the citizen has a right to "kick" at sixteen or seventeen points and two curve poles to each curve; at poles out of line raking in all directions, while varying in height, and of unsightly and rough appearance; at loose span wires, with enough kinks and twists to resemble a caterpillar on the move; at hangers and ears of unsightly appearance, standing at all angles and out of line; at pull-offs that hav been rendered useless by others being added, still left hang ing loose; at heavy, unsightly and bungling switches, crossovers and insulators, when they are not only unnecessary but a detriment to the successful operation of a road, I think every one will admit. Lots of poor and bungling work can be hid under the floor and behind the switchboard of a station, concealed behind the woodwork of a car, and covered up with earth on the track; but every part and parcel of the overhead construction stands up high and clear for all eyes to see, and the man who wishes his work to be a credit to him must see that every little detail is constructed with care, neatness and stability.

There is no doubt whatever that, by using good material and taking care with the construction, the overhead wires and supports not only need not mar the beauty of streets, but, in some cases, can be made an adjunct thereto, thus eradicating the only remaining objection to the trolley system.

Notes on Electromagnetic Machinery.—IV.*

BY WILLIAM S. ALDRICH, M. E.

The cycle of operations of electromagnetic machinery possesses features characteristic of the ether medium employed. The fundamental cycle is necessarily that of the



FIGS. 9 AND 10.—EPICYCLIC SPUR WHEEL MECHANISMS, DRIVEN BY ELECTRIC MOTORS.

physical condition of the medium at each point; following this are the energy cycles of the medium and throughout the mechanism, and the kinematic cycle of the mechanism of transmission. Or, perhaps more generally, the transformation or conversion cycles of the medium would be considered first, then the transmission cycles of the intermediate mechanism and machinery, through which the transformation cycles indicate the performance of useful work by the so-called mechanical forces of nature. Each of these elements of the complete cycle—the ether medium and the mechanism of transmission—may again be considered, especially with reference to the mechanics of the elements involved; that is, the mechanics of the electromagnet stresses of the ether medium as of a resistant body,† and the mechanics of the molecular stresses of the material elements of the electromagnetic machinery. In considering in a somewhat analogous way the mechanics of the medium and the mechanism of the steam engine Prof. R. H. Thurston‡ has extended the point of view along the lines of Rankine, and thus groups under the heading of mechanics:

(1) Statics, treating of the relations of forces in any system or medium, when no motion results from their action.

(2) Kinematics, treating of the relations of motion simply.

(3) Dynamics, or kinetics, treating of the action of forces accompanied by motion.

(4) Energetics, treating of the transfer, transformation, transmission or modification of energy, under the action of forces, from one mode of manifestation to another, and from one body to another.

Examining, for a moment, the application of the above to electromagnetism, with ether as the medium, it will be found that the lines have already been mathematically laid out by Maxwell in the direction of electrostatics, electrokinematics and electrodynamics, resting somewhat anteriorly upon Faraday's researches and posteriorly upon Hertz's experiments. We have noted the statical action of the electromagnetic stresses, when under more or less stability of equilibrium, as in the solenoid mechanisms; the kinematic conception of the ether mechanism, as stated in the former paper, has served fairly as a working hypothesis, in lieu of a better; while the dynamical conception has shown the ether to be a suitable medium for the transfer or transmission of energy accompanied by definite motions. In order to investigate the complete cycle of operations of an electromagnetic mechanism, the whole of its mechanics should be developed—for the ether medium and for the machine elements. This, therefore, involves the energetics of the medium, giving the etheric energy cycle (electrodynamic), as we have for the steam engine the thermodynamic cycle. And the energetics of the ether medium may come to be studied by autographic records of

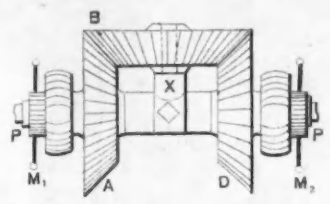


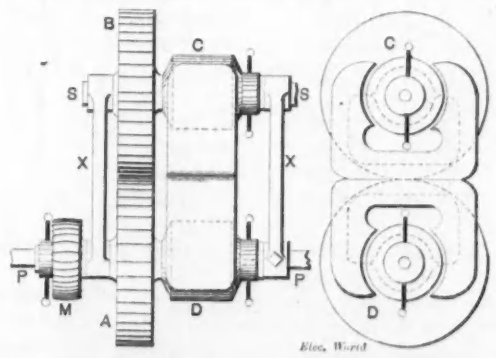
FIG. 11.—EPICYCLIC BEVEL WHEEL TRAIN OF MECHANISM.

its energy cycle, bearing the same relation to the electromagnetic mechanism that the indicator card does to the distribution of energy in the steam engine mechanism.

Differential electromagnetic mechanisms may consist: (1) of variable speed or power (or both) combinations effecting their purpose by electromagnetic action, not necessarily of itself differential; (2) of variable action mechanisms having a differential effect brought about in the electromagnetic stresses themselves. In the former case, the mechanism is inherently differential, whether controlled, operated or actuated electromagnetically or pneumatically; for instance, such would be a differential screw, pulley or other mechanically differential mechanism. In the second case, we have the two-coil solenoid, the solenoidal electromagnetic balance, and the dynamotor balance shown later, the differential action being due to a preponderance of a simple or of a resultant magnetic field over a surrounding field or fields.

Epicyclic gear-wheel mechanisms are differential in character, as may be seen by referring to Fig. 9. The motor armature M_1 and gear-wheel A are secured to a sleeve, loosely turning on shaft $P\,P$, and the motor armature M_2 and wheel B, similarly placed on shaft $S\,S$. Three principal combinations of these three elements of a simple kinematic chain are possible. (1) If the arms $X\,X$, connecting the shafts, are fixed—one machine will drive the other as a dynamo—the fields being supposed secured to the arms $X\,X$. (2) If shaft $P\,P$ is held in fixed bearings, field of M_1 stationary and both motors set in operation, the arms $X\,X$ will carry combination around the shaft $P\,P$, when the motors revolve at different speeds. The arms $X\,X$ will turn around in a direction dependent upon the direction of rotation of the motors, and at a speed proportional to the speed of the motors and the number of teeth on the wheels. When the wheels have the same number of teeth: (a) and the motors revolve at the same speed in the opposite direction, there will be no rotation of the arms; (b) motors revolve at different speeds, the arms will turn at a speed of half the difference of the motor speeds, and in the direction of the greater one. (3) If shaft $S\,S$ is fixed, instead of $P\,P$, field of M_2 stationary, similar combinations will produce similar results in effecting the rotation of the arms. Several minor combinations are possible in each case, but the above serve to show the differential nature of this form of a simple epicyclic gear-wheel train.

In Fig. 10 motion is communicated to the wheel B



FIGS. 12 AND 13.—COMBINATION OF SPUR WHEELS AND DYNAMOTOR IN AN EPICYCLIC TRAIN.

through the wheel C on same sleeve as B, and geared to D on same sleeve as motor armature M_2, loosely mounted now, on shaft $P\,P$. This is permanently mounted in bearings, and has no rotation, when the gear wheels $A\ D$ and $B\ C$ are of same size, and the motors M_1 and M_2 revolve at same speed in same direction. When the motors M_1 and M_2 revolve in the same direction at different speeds, the arm X (keyed to shaft $P\,P$) rotates at a speed equal to half the difference of the motor speeds.

In Fig. 11 bevel wheels have been substituted for the spur wheels of Fig. 10, reducing the number; as the bevel wheel B, loosely sleeved on the arm X meshes with A and D, and so performs the mechanical functions of both the wheels B and C, of Fig. 10. The motors M_1 and M_2 are mounted as before, and cause no rotation to the arm X or shaft $P\,P$ when they revolve in opposite directions at the same speed. When so revolving, at different speeds, they rotate the arm X at a speed of half their difference of speeds in the direction of the greater. This is the fundamental form of the Edison epicyclic street-car gear. A slight alteration in the speed of the motors above or below their normal speed, or one above and the other below the normal, will rotate the car-axle $P\,P$, and drive the car forward or backward, according to the direction of rotation of the motor having the greater speed. Sometimes the arm X and wheels $B\,C$, Fig. 10, are duplicated on the other side of the shaft, as in Fig. 16, which distributes the strains, but in no way changes the kinematical relations. A similar addition to Fig. 11 is to extend the arm X and loosely mount a fourth bevel wheel on it, between A and D. All of these are simply electrically driven epicyclic gears.

Epicyclic electromagnetic mechanisms may now be derived by substituting dynamotors (or double motors if needed) for the pair or pairs of gear wheels. In Fig. 12 the dynamotor combination $C\ D$ has been substituted for the two wheels $C\ D$, of Fig. 10, discarding motor M_2. For armature D being mounted on the same sleeve with A and M, and so driven by M, now operates as a dynamo, supplying current to armature C. This is on the same sleeve wheel as B. The dynamotor fields are secured to arm X. Therefore, while the motor M is run at a constant speed all the time, the dynamotor $C\ D$ being then operated as a variable speed dynamotor, the speed of C may be varied at will. As the fixed speed relation between the gear wheels A and B cannot change—an increase or decrease of the speed of C from the normal will cause the arms $X\,X$ to rotate the shaft $P\,P$, in the same way that Figs. 9 and 10 would operate if the motor M_1 were run at constant speed while motor M_2 should be varied as we have now supposed motor C to have been. Fig. 12 might also have been derived from Fig. 9 by putting in the dynamotor $C\ D$ instead of the motor M_2. Fig. 13 is a side view of the dynamotor of Fig. 12. This is yet a combination of mechanical and electromagnetic elements. Drop the wheels A and B, giving form in Fig. 14.

Fig. 14 is the true electromagnetic and epicyclic mechanism combined. The dynamotor fields are secured to the arms $X\,X$. The motor M driving it, tends to drive the armature A as a dynamo. Both A and B are connected up with the external circuit, either as a constant or a variable

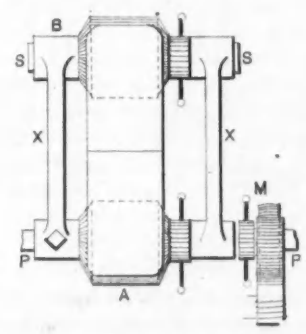


FIG. 14.—EPICYCLIC ELECTRO-MAGNETIC MECHANISM.

speed dynamotor. Therefore, if motor M runs free (open circuit) there is no rotation to the arms $X\,X$, while A and B are revolving all the time at a nominally fixed speed relation.

(a) Now, upon operating M as a motor, but against the rotation of A (and therefore, as a brake to A), the armature A will be slowed down, which will cause the field of the dynamotor and arms $X\,X$ to rotate in the opposite direction to armature A, in order to continue cutting the lines of force across armature A at the same rate as before, and so to maintain the constancy of the nominal speed relation between armatures A and B. Should the armature A be slowed down till it stops, the dynamotor field will increase its speed of rotation till up to the former speed of its armature A, and will maintain that speed, still in the opposite direction, as long as armature A is held stationary, by the armature of M, on its sleeve, being now electromagnetically clutched by its stationary field. Slowly releasing armature A will cause it to react against its dynamotor field, tending to stop it. When armature A is once more free the arms $X\,X$ are stationary again.

(b) By again operating M as a motor, but causing its armature to rotate in the same direction that it had been going when free, and increasing its energy gradually, it will cause the armature A so to react upon its dynamotor field as to continue to cut across the lines of force at the same rate as before, which will therefore give a rotation of the dynamotor in the *same* direction as its armature D.

Besides controlling the motion of the dynamotor field (and so of its arms $X\,X$, and shaft P^*P) entirely by motor M, it may be partly controlled by regulating the external circuit supply to the dynamotor fields and armatures.

Fig. 15 is a double form of this mechanism, derivable from Fig. 14 by adding another dynamotor, or from Fig. 12 by substituting a dynamotor $A\ B$ for the gear wheels $A\ B$. One or both of the dynamotors may be variable speed combinations, and one only or both may therefore be under control of the external circuit. The armatures A, D and M are all on the same sleeve, loosely mounted on shaft $P\,P$. The armatures C and D are on the same sleeve, loosely mounted on shaft $S\,S$. The operation is analogous to that of Fig. 14.

*A paper read before the Electrical Section of the Franklin Institute. For the first three sections of this article see THE ELECTRICAL WORLD of Feb. 13 and 27, and March 19, 1892.

†Resistant in the sense of acting as a body constantly maintaining its volume while undergoing any kind of alteration of its volume form.

‡"Manual of the Steam-Engine," Part I., pp. 298 and 304.

Fig. 16 is a double form of the gear wheel form of Fig. 10, and Fig. 17 is a double form of the combination shown in Fig. 12.

Three armature dynamotors are shown in Figs. 18 and 19, the former having a two branch magnetic circuit, and the latter a four-branch circuit. Either of these will serve for the combination shown in Fig. 17. All of the armatures of either Figs. 18 or 19 may be run: (*a*) as dynamos, with electrical output of current; (*b*) as motors, with mechanical output of power; or, (*c*) one or more may be run as dynamos supplying current for the remaining armatures, as motors, in the same magnetic fields. The differential operation of the branch circuits *C* and *D* would result in no flux of lines across armature *Q*, when the fields of *C* and *D* were exactly balanced. We have then electromagnetic equilibrium, as formerly in the solenoid mechanism, and more or less stable, according to the character of the balanced fields of force. Moreover, there is constant air gap resistance here, independent of the position of the balanced circuits, as was not the case with the differential coil and plunger mechanism. This eliminates the many disadvantages of the electromagnetic balance in the solenoidal form, and may give this type, or a modification, some useful purpose to fulfill as a measuring instrument. When there is an exact balancing of the magnetic flux from *C* to *D*, on each side, there will, of course, be no rotation of the armature *Q*. And when there is not a balance, it will either cause a rotation of the armature *Q* (if the dynamotor field is fixed), or cause an angular swing of the field (if the armature *Q* is held stationary). This swing of the field is somewhat analogous to the swing of the field of a dynamo when mounted in the form of the Brackett cradle dynamometer. Within certain limits the angular deflection is a measure of the torque.* Brackett states that if the counterbalancing effort of the spring balance or weights be removed, the field will perform a complete revolution and go on revolving, increasing in its speed till it and the armature (practically) revolve together; when, of course, there is no work done but in overcoming internal and external friction. This action of the field and armature is analogous to that considered for the combinations of epicyclic mechanisms, Figs. 14 and 15.

The efficiency of dynamotor transmission should approxi-

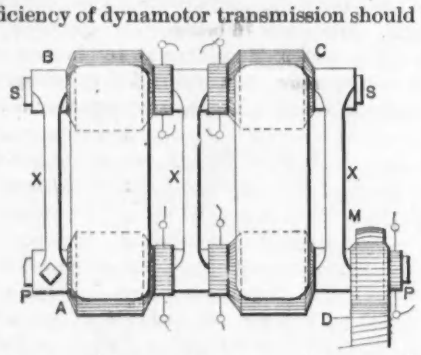
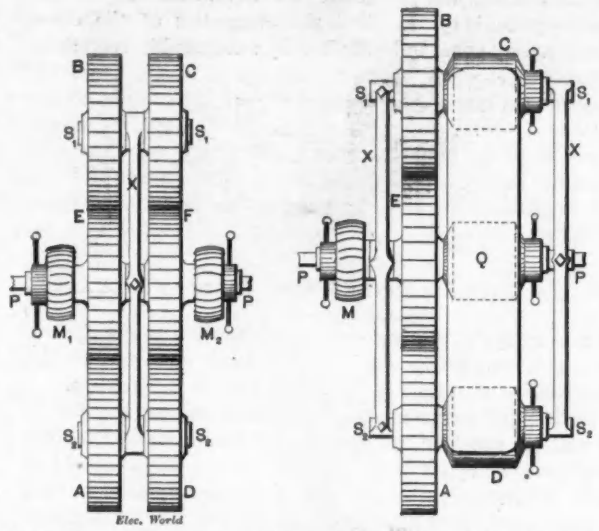


Fig. 15.—Double Form of Epicyclic Electro-Magnetic Mechanism.

mate to that of the motor dynamo transformers, the one being practically the reverse operation of the other. Silvanus P. Thompson has considered† continuous current transformers to be capable of a high average efficiency. Lahmeyer employed the principle of the dynamotor,‡ consisting of an armature turning nominally without load, as a variable resistance, to regulate the (constant) number of turns of the working armature. In Lahmeyer's constant current transformer,§ of the one armature type, wound both for high tension supply and low tension demand, all in one magnetic field—we have a form of construction of high practical value. There is higher efficiency at less cost and decreased size, with less sparking than in motor-dynamo transformers. With equal excitation this transformer works with a higher degree of magnetic saturation—because the reactions of the armature coils balance each other, a condition obviating sparking. The efficiency of transform ation is about 92 per cent. The Bernstein constant current transformer‖ has its motor armature wound with thick wire, the dynamo armature with thin wire, entirely separated longitudinally, and turning in a common magnetic field, which is excited by the current in the primary wire. Being a series field, with primary field in series with the thick-wire coils of the magnet, the speed varies directly as the electromotive force required, a peculiarity of some importance in certain work. Elihu Thomson's continuous current transformer,** for a three-wire system, has an armature consisting of a double winding of two separate sets of coils, the counterparts of each other in potential energy, and each set having a brush and commutator of its own. The armature windings of this so-called "compensator" are of quite low resistance and designed to give, at its normal speed, an E. M. F. respectively equal to that existing between the side wires and centre wire of the three-wire system. Isolated plant forms of dynamotor transformers are to be seen in the telephone and hotel service electrical work.†† And several typical forms of dynamotors were exhibited at the Frankfort Exhibition last year, details of which may be seen by referring to the current journal reports and correspondence of that period. Respecting the peculiar conditions likely to arise in using the dynamotor in form of an epicyclic mechanism, the field and armature both revolving. Patten has developed a form* of dynamo with revolving fields and armature. With careful design, construction and management of operations, the dynamotor should range as high as 90 per cent. efficiency as a maximum.

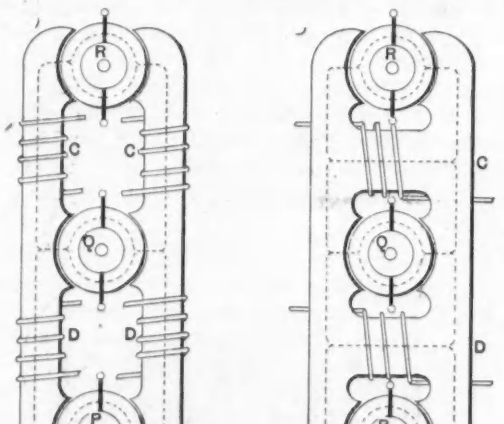
The kinematics of electromagnetic machinery has been touched upon in the foregoing sections, chiefly with reference to the propriety of including electromagnetically connected mechanisms with previous typical forms, the mechanical equivalents of dynamotors, and the conception of the electromagnetic kinematic chain. It remains to be



Figs. 16 and 17.—Double Forms of Epicyclic Mechanisms, Derived Respectively from Figs. 10 and 12.

seen whether this portion of the subject may be further developed along existing lines of treatment and classification, as outlined by Willis, Rankine and Reuleaux; or, whether it may not be found to require a peculiarly distinct treatment, owing to the special need of considering the character of the medium, and its own kinematics and dynamics. But, in the present state of our knowledge it is well to guard against too rigidly adhering to only the kinematical and mechanical conceptions of the ether medium. It is not that the true conception is necessarily otherwise; but because the electromagnetic mechanism appears to have many well known mechanical equivalents. For almost all the kinematical problems may be solved by electromagnetic connection, in some cases more readily than by mechanical devices.

The characteristic features of the ether medium led Maxwell to identify the two phenomena of light and electromagnetic waves, basing upon this identity his electromagnetic theory of light. Prof. Henry A. Rowland remarks† that "as yet we cannot conceive of the details of the mechanism which is concerned in the propagation of an electric current. . . . According to our modern theories of physics there must be some medium engaged in the transmission. . . . That medium which is supposed to extend unaltered throughout the whole of space, whose existence is certain, but whose properties we have yet but



Figs. 18 and 19.—Three-Armature Dynamotors.

vaguely conceived; . . . we have finally completely identified the ether which transmits light with the medium which transmits electrical and magnetic disturbances." And, regarding the possibilities bound up in the intensity of the electromagnetic stresses which are capable of being induced in the ether medium, Mr. A. E. Kennelly states‡ that they are far in excess of any stress which we can exert without the cohesion of matter. He estimates that one cubic inch of electromagnetically stressed air, magnetized to a flux density of 5,019 lines per cubic centimetre, and alternated 227 times per second, would store and release energy at an average rate of 1 h. p. So that for range of adaptability in meeting the requirements of comparative and constrained motion, as well as for great concentration of energy in the transmission and transformation of energy' the ether medium stands out alone, yet with a rapidly increasing field of application.

Oil as an Insulator.

BY PROF. D. E. HUGHES, F. R. S.*

[*Abstract.*]

A short time ago Mr. Preece credited Prof. Hughes as being the first to propose the use of oil as an insulator, in reply to which Prof. Hughes read an interesting paper, from which we abstract the following:

He states that he was the first to use the hydrocarbon oils, such as petroleum and rosin oils, as an insulator 33 years ago. The failure of the first Atlantic cable in the year 1858 led him to see the need of some form of insulation that possessed self-restoring powers, so that if punctured by lightning or ordinary working currents the puncture would be closed by some simpler process than having to take up a portion of the cable. Taking a lesson from nature, which restores punctures and mechanical injuries to living objects by the ejection of a liquid sap or blood, he was led to the fact that he might inclose in a cable an insulating self-restoring medium in the form of a liquid. Faraday had found some years previously that oil of turpentine had high insulating properties, which led Prof. Hughes to experimenting with samples of oils.

In testing these samples he used the ordinary frictional electric machine. He charged a battery of Leyden jars to a known degree, indicated by a Peltier electrometer. These jars, when charged, were put in communication with a short piece of cable to be tested. If the insulation of the few inches of cable was bad, the Leyden jars would be instantly discharged through the defective insulation, but if the insulation was comparatively perfect, the time of the discharge, as indicated by the electrometer, was a correct measure of its insulating properties.

He found after numerous experiments that pure rosin oil gave the highest insulation of all. A spark that would pierce a given thickness of gutta percha would utterly fail to pierce the same thickness of rosin oil. While, if the gutta percha was pierced, its insulation was destroyed and could not be easily restored to its former condition, on the other hand, if by accident the rosin oil was pierced, it, by its own mobility, at once restored the insulation to the original state. Rosin oil at the same time had a preservative effect upon gutta percha, for the sheets immersed in this oil had become slightly increased in weight, showing that it had penetrated into the pores of the gutta percha. At the same time it was stiffer and tougher than before its immersion. He exhibited a specimen of this fluid cable made 33 years ago. The gutta percha after 33 years' exposure to the air, was apparently as good an insulator as when first made.

The first experiments were made with gutta percha coated wires immersed in the oil. He followed this with experiments on copper wire wound with well dried cotton or hemp, which was then drawn into a small lead tube filled with rosin oil. The cotton covering was merely to keep the wire concentric. It will be seen that these tests were identical both as to form and material with those patented by David Brooks, of Philadelphia, some 15 years later. Those of Prof. Hughes are described in his English patent of Jan. 11, 1859.

He next experimented with thick, heavy oil, whose rate of flow would be small in case of puncture of the cable. This would displace any water in the puncture, provided that there was a slight head pressure given to the oil at the reservoir at certain landing stations. For this reason he preferred to use rosin oil, which is already thick and can be made more so by the addition of solid rosin, which dissolves in it, or by the addition of palm oil residue, which has a remarkable property of thickening rosin oil.

In order to satisfy those who might object to even a small leakage of oil at the puncture, he made several compounds of rosin oil, mentioned in his patent, that would harden when in contact with water and thus prevent any waste of oil at the fault or puncture.

After having found this high insulating property of rosin oil he coated all his Leyden jars or other parts where he desired high insulation with it, and by this means was enabled to retain a full charge in the Leyden jars for several hours, in an atmosphere full of humidity.

His tests seemed to show that the value of oil as an insulator increased both with the potential of the charge and also with the rapidity of alternations, for when the experiments were made with an impulsive rush, so as to have the greatest number of oscillations, per second, say 1,000,000, then even the poorest oil, even castor oil, showed marked superiority over air or gutta percha.

He found that a spark or charge from a Leyden jar which would easily pierce four inches of air would not pierce $\frac{1}{10}$-inch of rosin oil, proving that this oil, when resisting an impulsive rush and discharge, has 79 times the insulation resistance of air. In another case he found that the spark preferred to pierce the glass vessel in which the oil was placed, and traverse several inches of air rather than traverse a distance of $\frac{1}{10}$-inch through oil.

He then showed an experiment with a lead-covered oil cable placed in a tank of water. It was pierced so as to force a leak, but the oil entering the puncture immediately filled up the hole and the insulation was as perfect as before.

*Paper read before the Institution of Electrical Engineers, London.

*Used at the Stevens Institute of Technology, 1884, and described in The Electrical World, Jan. 5, 1884.

† Paper before the International Electrical Congress on "Constant Current Transformers," Paris, 1889. See The Electrical World, Sept. 21, 1889.

‡ The Electrical World, Oct. 12, 1889.

§ *Engineering*, London, May 29, 1891, p. 642.

‖ The Electrical World, Jan. 25, 1890.

** The Electrical World, April 16, 1887.

†† *Electrical Engineer*, New York, Dec. 23, 1891.

* The Electrical World, Nov. 26, 1887.

† "On Modern Views with Respect to Electric Currents." *Transactions American Institute of Electrical Engineers*, vol. VI., No. 7, July, 1889.

‡ *Transactions American Institute of Electrical Engineers*, vol, VIII., No. 11, November, 1891.

Application of the Weston Voltmeters and Ammeters to Practical Electrical Measurements.—II.

BY H. MASCHKE, PH. D.

§ 11. *Special Remarks About the Weston Voltmeters.*—The different types of the Weston voltmeters and millivoltmeters may be seen from the following table:

Voltmeters.

No.	Scale.	Value of one scale division.	Capable of being read to:	Approximate resistance.	Remarks.
	Volts.	Volt.	Volt.		
1....	0-150	1	1/10	18,000 ohms.	
2....	0-150	1	1/10	18,000 "	Contact key and calibrating coil.
3..	0-150	1	1/10	18,000 high volt coil.	Contact key.
	0-5	1/30	1/300	600 low volt coil.	
4	0-150	1	1/10	18,000 high volt coil.	Contact key.
	0-15	1/10	1/100	1,800 low volt coil.	
5....	0-300	2	1/5	36,000 ohms.	Contact key and calibrating coil.
6....	0-450	3	1/5	54,000 "	Contact key and calibrating coil.
7....	0-600	5	1/2	72,000 "	
8....	0-600	5	1/2	72,000 "	Contact key and calibrating coil.
9	0-600	4	1/2	72,000 high volt coil.	
	0-150	1	1/10	18,000 low volt coil.	Contact key.
9½	0-750	5	1/2	90,000 high volt coil.	
	0-150	1	1/10	18,000 low volt coil.	Contact key.
10..	0-600	4	1/2	72,000 high volt coil.	
	0-300	2	1/5	36,000 low volt coil.	Contact key.
11 ...	0-750	5	1/2	90,000 ohms.	
12....	0-1,500	10	1	180,000 "	

The instruments Nos. 3, 4, 9, 9½ and 10 are supplied with a double scale.

High Range Voltmeters.—Each of these instruments consists of a No. 1 voltmeter with a separate box containing a certain resistance. The values of the scale divisions

FIG. 10.—WESTON VOLTMETER.

must then be multiplied by a certain number given in the following table when the instrument and the resistance box are connected in series. The scale is divided into 150 divisions, and if used without the resistance box the instrument serves simply as a No. 1 voltmeter.

No.	Range.	Multiplying power of the resistance box.	Capable of being read to:	Resistance.
13	0-2,250 V.	15	1½ volts.	270,000 ohms.
14	0-3,000 "	20	2 "	360,000 "
15	0-3,750 "	25	2½ "	450,000 "
16	0-4,500 "	30	3 "	540,000 "
17	0-5,250 "	35	3½ "	630,000 "
18	0-6,000 "	40	4 "	720,000 "

Millivoltmeters.

No.	Scale.	Value of one scale division.	Capable of being read to:	Approx. resist.	
	Volt.	Volt.	Volt.	Ohm.	
1	0-1/10	1/1000	1/10000	1/2	Zero in the centre of the scale; 100 divisions right and left.
2	0-1/100	1/10000	1/100000	1/2	
3	0-1/100	1/10000	1/100000	1/2	Zero in the centre; contact key reducing the sensibility ten times.
	0-1/10	1/1000	1/10000	5	

The instruments are all constructed in the same way, except the millivoltmeters, in which the movable coil is wound differently. They differ only in the amount of resistance inserted in the circuit in series with the coil. These additional resistance coils are located concentrically with each other underneath the scale plate; in the instrnments intended for the highest voltage they are placed in a neat separate box accompanying the instrument.

For the voltmeters, furnished with a double scale or with a calibrating coil, two binding posts are provided for the negative wire.

If connected to the rear binding post of a double scale instrument, the readings are to be taken on the lower scale. If, however, connection is made to the front binding post. additional resistance coils of the apparatus are inserted in circuit and the upper scale is to be used. For use of the calibrating coil see Sec. 32.

If the largest resistance added to the instrument in a separate box is used, readings can be taken up to 6,000 volts. On the other hand the smallest pressure, to be read with the millivoltmeter, is 0.00001 volt.

The value of the resistance of the voltmeter measured exactly to one hundredth of an ohm at 70 degrees F. is marked on every instrument.

§ 12. *Special Remarks About the Weston Ammeters.*—The ammeters are identical with the voltmeters as far as the appearance of the apparatus, the construction of the magnetic field, the movable coil, etc., are concerned. They differ only in that respect that a shunt is provided within the instrument through which the current to be measured is conducted, and to the ends of which the wires leading to the movable coil are connected. The construction of the shunt is such that the current passing through the same

FIG. 12.—WESTON AMMETER.

can by no means directly affect the magnetic field. It consists of two copper plates separated by a thin insulating layer, which are located in the space left vacant by the magnet, and connected directly to the two binding posts situated on the right hand side of the ammeter.

These copper plates are connected with each other by a certain number of insulated wire coils arranged in multiple arc, the winding being conducted round the magnet in such a manner that every two neighboring wires are passed by the current in opposite directions.

Ammeters.

No.	Scale.	Value of one scale division.	Capable of being read to:	Approx. resistance.
	Amp.	Amp.	Amp.	
1	0- 5	1/10	1/100	0.007
2	0- 15	1/10	1/100	0.0022
3	0- 25	1/4	1/40	0.0013
4	0- 50	1/2	1/20	0.00066
5	0-100	1	1/10	0.00033
6	0-150	1	1/10	0.00022
7	0-200	2	1/5	0.00016
8	0-250	2	1/5	0.00013
9	0-300	2	1/5	0.00011

Milliammeters.

No.	Scale.	Value of one scale division.	Capable of being read to:	Approximate resistance.
	Milliamp.	Milliamp.	Milliamp.	
0	0-150	1	1/10	0.22
1	0-300	2	1/5	0.11
2	0-600	5	1/2	0.055
3	0-1,000	10	1	0.033
4	0-1,500	10	1	0.022
5	0-500	5	1/2	0.066
	0-50	1/2	1/20	0.66
6	0-500	5	1/2	0.19
	0-10	1/10	1/100	10.5

The instruments Nos. 5 and 6 have a double scale.

The resistance of the shunt is adjusted in ammeters and milliammeters so as to produce a drop of potential of about 0.03 volt when the strongest current allowable for the instrument is applied. The resistance of the movable coil and the two springs is 0.5 ohm. While the instruments intended for strong currents read up to 300 ampères, the milliammeters will measure a current of 0.00001 ampère.

APPLICATIONS.

A. MEASUREMENT OF POTENTIAL DIFFERENCES.

§ 13. *Measuring the Electromotive Force of Batteries.*—For measuring the E. M. F. of a single cell the voltmeter No. 3 is used. The negative pole of the cell is connected to the rear binding post at the left side, the positive pole

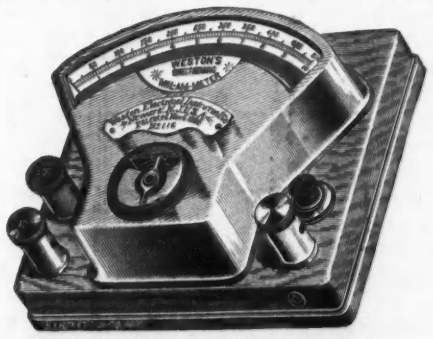


FIG. 13.—WESTON MILLIAMMETER.

to the binding post at the right side. (See Fig. 14.) The readings then are taken on the lower scale.

Since this scale ranges from 0 to 5 volts, and is divided into 150 divisions, each division corresponds to 1/30 of one volt, and since 1/10 of a scale division may be distinctively estimated, the readings will be exact to 1/300 of a volt.

If the pointer should be deflected to the wrong side, *i. e.*, to the left, this would show that the poles of the cell have been connected with the binding posts the wrong way, and the connections must be exchanged. The following is an easy rule to remember the polarity of a galvanic cell: The word "zinc" contains an *n* which, at the same time, is the first letter of the word "negative," and in the usual batteries the zinc pole is always the negative pole.

If the E. M. F. of several cells arranged in series is to be measured, the zinc pole is to be connected with the front binding post at the left hand (Fig. 15), and the deflection of the pointer is to be read on the upper scale. Since each division of this scale is equivalent to one volt the readings will be correct to 1/10 of a volt by estimating the tenth part of a scale division.

In case many measurements of E. M. Fs. are to be made in succession in a complicated system of conductors, in which the polarity of the current is not always known at the start, it is convenient to use an instrument provided with a reversing key. Turning the knob located behind the positive binding post by 90 degrees will reverse the direction of the current in the instrument, while turning it only 45 degrees will interrupt the current. When the needle is deflected the arrow marked on the head of the

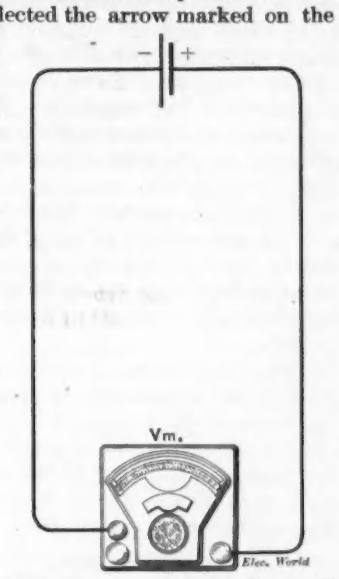


FIG. 14.—MEASURING THE E. M. F. OF BATTERIES.

knob always points toward the binding post at which the current enters, that is, the positive pole.

Other methods of measuring the E. M. F. of batteries will be explained in Sec. 16 below.

§ 14. *Voltage of Dynamos.*—For measuring the difference of potential or voltage of a dynamo, the front negative binding post is to be used and the readings are taken on the upper scale. The voltmeter is connected either to the poles of the dynamo or, if more convenient, to the switchboard.

If the polarity of the machine be unknown, the Weston voltmeter will serve as a pole-finder. If on connecting the instrument the needle is deflected to the right, the pole connected to the binding post at the right hand is the positive one. For galvanoplastic machines, charging accumulators, arc-light plants, etc., the polarity of the current must be known, and therefore this feature is of importance in these cases.

If the pressure to be measured exceeds 150 volts, it would of course be best to use a voltmeter designed for such higher readings. But if such an instrument is not at hand, the measurement may nevertheless be made with the instrument ranging only to 150 volts, if a suitable additional resistance is joined up in series with the instrument. The

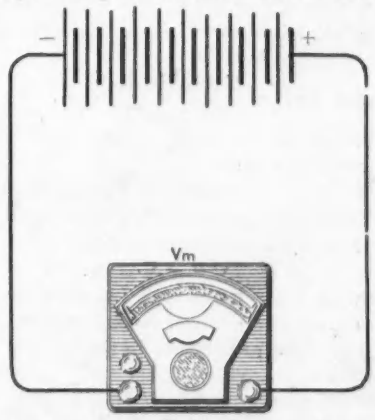


FIG. 15.—MEASURING THE E. M. F. OF A SERIES OF CELLS.

amount of this resistance is to be selected according to the following rule:

Let V be the upper limit of the number of volts to be measured, and r the resistance of the 150 volt voltmeter. Then the number of ohms R of additional resistance must be made equal to

$$R = r \times \frac{V - 150}{150} \text{ ohms.}$$

To find the correct value of the reading in this case the reading of the voltmeter must be multiplied by

$$\frac{V}{150}.$$

If, for instance, the resistance of the voltmeter is 18,000 ohms, and if it is desired to read up to 450 volts, then,

$$V = 450 \text{ and } r = 18{,}000,$$

and therefore the additional resistance must be equal to

$$18{,}000 \times \frac{450 - 150}{150} = 36{,}000 \text{ ohms.}$$

The readings of the instrument then are to be multiplied by

$$\frac{450}{150} = 3.$$

Suppose for instance that the pointer indicated the scale

division 115.6, the real number of the volts measured would be $3 \times 115.6 = 346.8$ volts. One scale division would in this case correspond to 3 volts.

Should it not be convenient to use the exact value of this additional resistance as given by the above formulæ, then any other known resistance R_1 may be used, and the readings must then be multiplied by

$$\left(\frac{R_1}{r} + 1\right)$$

to give the correct value.

§ 15. *General Rules to be Observed in Using the Voltmeters.*—A very valuable feature of the Weston voltmeters is their high internal resistance. The reason why this is of such great importance wherever measurements of differences of potential are to be made will be understood from the following:

If in Fig. 16 E is a current generator (dynamo, battery, etc.), sending a current through the circuit A B while the voltmeter is not yet connected with the circuit, a certain difference of potential will exist between the points A and B. If then the terminals of the voltmeter are joined to the points A and B, a small part of the current will pass through the voltmeter, whereby the potential difference between A and B will be diminished slightly.

The difference of potential measured by the voltmeter is therefore not quite the same which existed between A and B before the voltmeter was connected. If, however, the resistance of the voltmeter is high, the variation is exceedingly small; the variation is smaller the greater the resistance of the voltmeter.

A short calculation and a few numerical examples will show clearly how perfectly the accuracy of measurement is maintained in these voltmeters. For instance, let E, Fig. 16, be the E. M. F. of the generator; R, the resistance of the generator and the parts A E and B E of the circuit; R_1, the resistance A B; then, if the voltmeter is not connected the difference of potential between A and B is:

$$e = \frac{R_1}{R + R_1} \times E.$$

If now the voltmeter is connected to A and B, the differ-

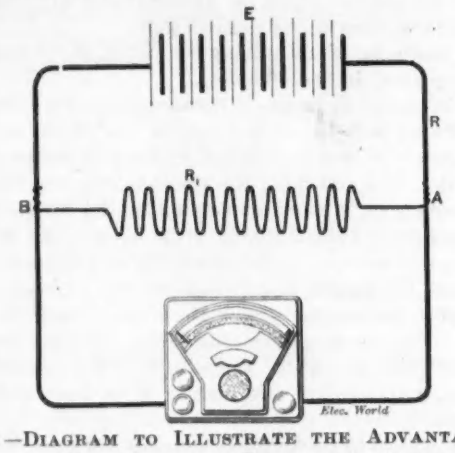


FIG. 16.—DIAGRAM TO ILLUSTRATE THE ADVANTAGE OF THE HIGH INTERNAL RESISTANCE OF THE WESTON VOLTMETERS.

ence of potential between these points drops a little and becomes:

$$e_1 = \frac{r \times R_1}{r \times R_1 + R \times R_1 + R \times r} \times E,$$

in which r is the resistance of the voltmeter. The difference between e and e_1 is:

$$e - e_1 = \frac{1}{r} \times \frac{R_1 \times R}{R_1 + R} \times e_1,$$

and this expression will evidently be the smaller the greater r, the resistance of the voltmeter.

If for instance $E = 2$ volts, $R = 3$ ohms, $R_1 = 2$ ohms, and the resistance r of the voltmeter suitable for this case (0 to 5 volts) is 600 ohms the error will be:

$$e - e_1 = 0.0016 \text{ volt.}$$

If, however, an instrument had been used of only ten ohms resistance, the error would have been equal to 0.09 volt, or about 60 times as much as in the foregoing case.

The expression $\frac{R_1 \times R}{R_1 + R}$ represents the joint resistances of the parts A B and B E A of the circuit, if connected in multiple arc. We may therefore say that the error depends only on the proportion of this resistance to the resistance of the voltmeter.

If the measurement is to be correct to p per cent., the resistances R_1 and R must be chosen in such a way that $\frac{R_1 \times R}{R_1 + R}$ is smaller than $\frac{p \times r}{100}$ ohms.

If the circuit is not closed by a resistance R_1, the voltmeter is directly connected to the poles of E, and the value of e_1 becomes:

$$e_1 = \frac{r}{r + R} \times E.$$

The error of measurement or the difference between the value indicated by the voltmeter and the true value is:

$$E - e_1 = \frac{R}{r} \times e_1.$$

This error becomes smaller the larger the resistance of the voltmeter is in proportion to the internal resistance of the current generator.

If the measurement of the E. M. F. is to be correct to p per cent., the internal resistance R of the generator must be smaller than $\frac{p \times r}{100}$ ohms in which r is the resistance of the voltmeter.

It will now be readily understood that the E. M. F. of cells of high internal resistance, as, for instance, that of Clark cells, cannot be determined by the method explained in Sec. 13, not even with voltmeters of so high a resistance as that of the Weston instruments. If for instance the E. M. F. of a Clark cell is 1.438 volts and its internal resistance 1,500 ohms, a voltmeter connected with the poles of the cell would show, not 1.438 volts, but only 0.41 volts.

The best and most exact way of determining the E. M. F. of those high resistance cells is the Poggendorff-Clark method, explained in the following section.

§ 16. *Comparison of Electromotive Forces of Batteries.* (1.) *Wheatstone's Method.*—Suppose the E. M. F. E_1

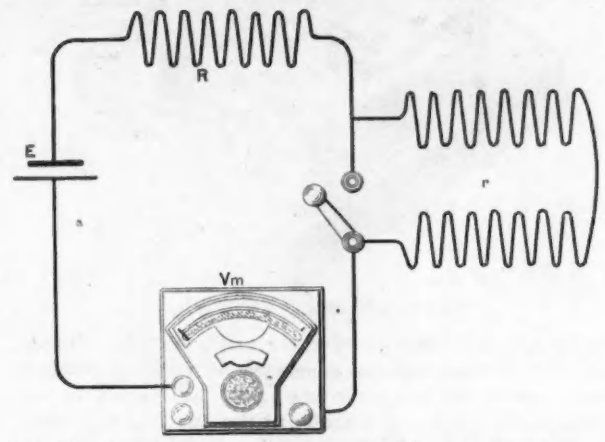


FIG. 17.—COMPARISON OF THE E. M. FS. OF BATTERIES BY THE WESTON VOLTMETERS.

and E_2 of two cells E_1 and E_2 are to be compared with each other (Fig. 17).

First connect E_1 in series with the voltmeter and a resistance R_1 and note the deflection V_1 of the pointer. Then increase the external resistance by an additional resistance r_1 and note the deflection V_2. Now join up the cell E_2 with such a resistance R_2 that the same deflection V_1 is obtained as before. Finally increase R_2 by a resistance r_2 so as to make the deflection equal to V_2. Then:

$$E_1 : E_2 = r_1 : r_2.$$

If E_1 is smaller than E_2 the resistance of the voltmeter itself may be taken as R_1. It is preferable to make r_1 about twice as large as the combined resistance of E_1 and R_1.

In this method it is not necessary that the internal resistances of the cells be small compared with the resistance of the voltmeter.

Example: Let R_1 (the resistance of the voltmeter) be 600 ohms, and $V_1 = 1.45$ volts; let r_1 be 1,200 ohms and $V_2 = 0.48$ volt. If then upon inserting E_2 an additional resistance of 36 ohms is required to make the deflection equal to 1.45 volts and a resistance $r_2 = 1{,}275$ ohms to produce the deflection of 0.48 volts we shall have

$$E_1 : E_2 = 1{,}200 : 1{,}275,$$

therefore $E_2 = 1.062\ E_1$ and $E_1 = 0.941\ E_2$.

If the readings are correct to $\frac{1}{10}$ of a scale division, the error of measurement will be equal to about 1 per cent.

(2.) *Poggendorff's Method Modified by Clark.*—This method is very convenient for comparing the E. M. F. of any element T, of low or high internal resistance, with that of a standard cell S (see Fig. 18).

B is a battery having a higher E. M. F. than either of the elements S and T to be compared. In series with B are connected a resistance R and a wire A D, along which a sliding contact may be moved. A millivoltmeter is connected with one pole to A, and the other to that pole of S which has the same polarity as the pole of B directly con-

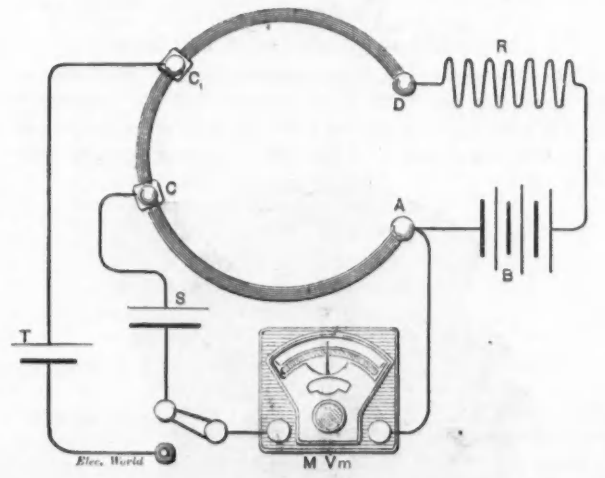


FIG. 18.—COMPARISON OF THE E. M. F. OF ANY ELEMENT WITH THAT OF A STANDARD CELL.

nected to A. The other pole of S is connected to the sliding contact, and is moved to such a point C that the voltmeter points exactly to zero. Let r be the resistance of A C. The cell S is then disconnected, and the other cell T joined up in like manner to the millivoltmeter and the sliding contact. The latter is again brought to such a point C_1 that no current is indicated by the millivoltmeter. Let the resistance of A C_1 be r_1. The proportion of the E. M. Fs. of S and T then will be:

$$T : S = r_1 : r.$$

In practice it is most convenient to arrange the apparatus so that the value of T may be read directly in volts. To accomplish this, the wire A D is stretched over a suitably divided scale, the division starting at A. If now, for instance, S is a Clark cell having an E. M. F. of 1.44 volts, let the sliding contact connected to S be placed to division 144 and the resistance R be adjusted so as to bring the millivoltmeter to zero. After this adjustment is made, each of the divisions of the scale means $\frac{1}{100}$ of a volt. If, therefore, S is replaced by T, and if the sliding contact must be moved to division 175 in order to make the millivoltmeter point to zero, the E. M. F. of T is equal to 1.75 volts. The accuracy of this method is exceedingly high, if the resistance of S and T are only a few ohms. In case the resistance of S is as high as in the usual Clark cell, the accuracy amounts to about 0.4 per cent.

§ 17. *Electromotive Force of Thermo Elements.*—For measuring and comparing small E. M. Fs., as for instance in thermo couples, the Weston millivoltmeter is peculiarly well adapted. Since, for instance, the E. M. F. of a thermo couple consisting of iron and German silver is equal to about 15 microvolts for a difference of temperature at the joints of one degree F., a difference of 20 degrees F. will give an E. M. F. of 0.0003 volt, corresponding to three divisions of the millivoltmeter. An error of $\frac{1}{10}$ of a scale division would correspond to an error of 0.00001 volt. The E. M. F. of the couple corresponding to one degree F., which is $\frac{1}{30}$ of the E. M. F. actually measured, may therefore be measured to 0.0000005 volt $= \frac{1}{2}$ microvolt.

To avoid inaccuracy of measurement it is necessary that the resistance of the thermo couple be small compared to the resistance of the millivoltmeter (which is about 0.5 ohm). If, for instance, the result shall be correct to 1 per cent., the resistance of the thermo couple must (according to the rules given in Sec. 15) not be higher than $\frac{1 \times 0.5}{100} = 0.005$ ohm. If an accuracy of 5 per cent. is sufficient the resistance may be $\frac{5 \times 0.5}{100} = 0.025$ ohm.

If the resistance of the thermo couple is larger than

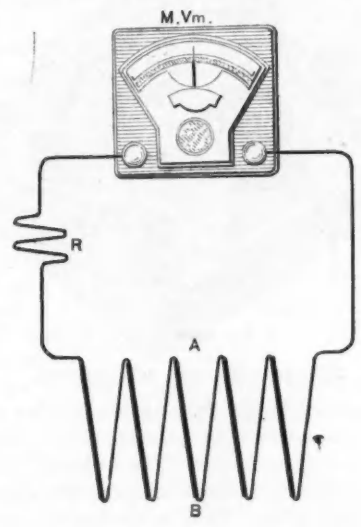


FIG. 19.—ELECTROMOTIVE FORCE OF THERMO ELEMENTS.

those limits of accuracy would permit, the measurement can still be carried out properly, if the formula explained in Sec. 15 is used. Let E be the E. M. F. to be measured, e the one indicated by the instrument, R the resistance of the thermo element, while the resistance of the instruments is 0.5 ohms. The formula mentioned will show that:

$$E = \left(1 + \frac{R}{0.5}\right) \times e.$$

For instance, let the resistance of the thermo couple be 0.46 ohm and let the E. M. F. indicated by the voltmeter for a certain difference of temperature be 250 microvolts. The true E. M. F. of the thermo couple will then be

$$E = (1 \times 0.92) \times 250 = 480 \text{ microvolts.}$$

Since the resistance R of a thermo couple may very easily be determined, care being taken that the joints are at equal temperature, the formula given above will allow of a very general application.

It is hardly necessary to mention that in a great many cases the range and accuracy of measurement may be considerably increased by using a number of thermo couples connected in series, instead of a single one.

In some cases it is necessary to know the temperature existing in an inaccessible place. Then a millivoltmeter connected to the poles of a small battery of thermo couples may serve as a thermometer, the wires of the battery being led to the place where the observer is. It is easy to make such an adjustment that each scale division of the millivoltmeter corresponds to 1 degree F., if only differences of temperature of about 35 degrees F. are to be measured. If for instance five iron wires are soldered to 5 wires of German silver, as shown in Fig. 19, a difference of one degree in the temperature of the joints A and B would produce an E. M. F. of about 100 microvolts. This corresponds just to one scale division of the millivoltmeter. It is advisable to insert a small variable resistance R into the circuit and to calibrate the millivoltmeter for its use as a thermometer by comparison with a common thermometer. It should be remembered that this arrangement will measure the *difference* in the temperature at the two sets of joints of the thermo-pile. To measure the actual temperature requires that that at one set of joints be maintained constant.

Lightning Arresters, and the Discovery of Non-Arcing Metals.—II.*

BY ALEXANDER J. WURTS.

I next replaced the wire I was using, which was much battered and bruised, with a new wire, and found the charge much diminished by the superior insulation. The latter was then replaced by bare wire insulated with a glass tube. The spark now was scarcely perceptible, being about the size of the spark obtained from a Leclanché cell, and even this could be obtained only after several minutes of charging. These results seemed to indicate a gradual charging of the wire by more or less perfect contact with an atmosphere having a different potential from that of the earth. With the idea of gradual charging in mind, the following plan was hit upon for a lightning arrester. The first conception was to alternately ground both poles of a generator over a very small air-gap, and at rapidly recurring intervals. The improved plan, however, was to alternately dead ground the poles of an alternator at every neutral point in the electromotive force wave, the idea being to so constantly discharge the line in this manner as to effectually prevent a charge from attaining any considerable intensity, and at the same time avoid the short circuit which now invariably follows the discharge over the air gap of our present arresters. The method of carrying out this plan will be understood by a glance at Fig. 6. Upon experimenting I found that an alternator could be short circuited at the neutral point without a spark. If the short circuit occurred a little before the neutral point, that is, on a decreasing electromotive force, there was slight sparking, but no tendency to hold on. If the short circuit occurred at all after the neutral point, a furious arc was established which would hold on indefinitely.

This form of arrester has not yet been tested in actual practice, but it will be during the coming season, and I have great hopes that it will not only successfully discharge the line, but effectually prevent any considerable accumulation of the charge. Of course this form of arrester is only adapted to alternators.

For direct current use I have devised something quite similar, the principle of which will be understood by reference to Fig. 7. Referring to the figure, *A* is a generator one pole of which is grounded at *G*, the other being con-

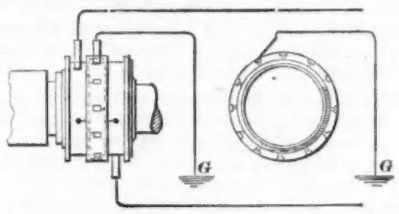


FIG. 6.—WURTS' LIGHTNING ARRESTERS.

nected to the trolley line *L*; *E* is a circuit controlling device consisting of fixed commutator like metal pieces e^1, e^2, e^3, opposite pieces being electrically connected; F^1, F^2 are brushes insulated from each other and revolving at a high speed in a direction indicated by the arrow, F^1 is connected to earth, and F^2 to the line; e^1, e^2, e^3 are connected respectively to three condensers, C^1, C^2, C^3, the latter being grounded as indicated at *d*. The action is as follows: With the brushes in their present positions, the line is connected through F^2 and and e^3 to condenser C^2. This condenser is therefore being charged while condenser C^1 is being discharged to earth through e^1, F^1. When F^2 passes to e^1, condenser C^1 will be connected to the line, and become charged while condenser C^3 will be discharging through e^3 and F^1. Thus by the continued rotation of these two brushes, it will be seen that the trolley line is being constantly discharged into a fresh condenser.

This arrester has also not been tested in actual practice, but if my hopes are fulfilled it will accomplish for direct current circuits what the neutral point arrester is intended to accomplish for alternating circuits, the idea being in either case to take off the charge bit by bit, but at such rapidly recurring intervals that the line will be kept practically free from charge, or, at least prevent the charge from obtaining sufficient intensity to damage any portion of the system. Personally I am much interested in these two arresters, which practically afford direct connection to earth without dynamo leakage, and would like to dwell on them more in detail, but time will not permit.

Referring once more to my experiments with charged wires, I would say that they were nearly all repetitions of experiments quite familiar to all of you. Let me, however, call your attention to one of them which I am confident is not old in detail. Referring to Fig. 8, *L* is a Leyden jar, *l* is a bare line wire, a portion of which is coiled and immersed in a tank *K* of water. This tank is well grounded. Line *l* is continued through induction coil *C* and then grounded as shown; *b* is a gap discharge circuit. Now with a spark at *A* there was a small spark at *b*; with a gap at *d* there was sparking at *d* and *b*, spark *d* being larger than *b*. With a gap at *e* sparks were obtained simultaneously at *d*, *b* and *e*. Induction coil *C* was either a primary or a secondary of a 40-light converter. When *C* was primary, spark *e* was very small. When *C* was secondary *e* was larger, but still small when compared with *d* and *b*. From these experiments I learned two lessons, both of them old, but in books they did not impress me as they did in practice. The first lesson was, that I must not expect one or two discharge circuits to discharge the many miles of wire that we have in our lighting and power circuits. The second was that a "kicking coil," no matter how great its impedance, would still take a portion of the discharge. My final conclusions then were: that, in order to afford the best possible protection for electric plants, the wires must fairly bristle with discharge points properly located in discharge circuits. With this idea in mind a cheap and effective pole arrester seemed to be the proper thing to look for.

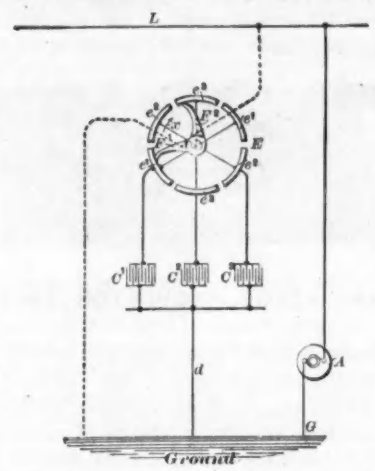


FIG. 7.—WURTS' LIGHTNING ARRESTERS.

My experiments from this time on led me to a discovery so remarkable, and so contrary to all previous ideas, that I am going to read you a description of them.

In designing the arresters already described, I had followed closely the rut of previous practice, which had always been to provide with each discharge circuit a circuit interrupting device. Upon reflection, however, it was evident that one circuit interrupter placed in the main circuit would interrupt the arc on any discharge circuit. For a moment the problem of a simple pole arrester seemed solved, but on second thought the difficulties and inconveniences inseparable from any automatic main circuit interrupter appeared to be insurmountable, and the idea was no sooner conceived than it was abandoned. And yet, poor as it was for practical purposes, it proved a good stepping stone, and led to the following plan, viz.: To provide the line with ordinary discharge circuits, that is, with the well known saw-tooth protectors, made of carbon so that they would not easily burn away; and then in the station, between the generator and the first discharge circuit, provide an automatic device which, upon the passage of an abnormal current from the generator, would instantly short circuit the dynamo and as quickly open again, the intention being that should a short circuit occur out on the line through any of the discharge circuits, a short circuit at the dynamo would so reduce the pressure on the line as to render it impossible for an arc to maintain itself. Then, any such arc having been extinguished, the short circuit at the generator could be interrupted and the service would continue as before. This idea meeting with general approval, steps were at once taken to put it to a test in the following manner: To a 1,000-volt alternator there was connected a circuit consisting of about 100 yards of line wire, and in this circuit there was placed a pair of carbon dischargers having saw-tooth edges, and a $\frac{1}{16}$-inch air gap, also a switch. In shunt with this circuit, that is, direcly across the terminals of the generator, there was connected a simple device (it will not be necessary to explain its construction) which, upon the passage of an abnormal current in the circuit containing the discharges, would instantly short circuit the generator and as quickly open again. All the connections being made, the air gap was bridged with a bit of tinfoil to start the arc, and the switch thrown. The actions that followed in an inconceivably short space of time were these: The tinfoil burst with a snap, an arc was formed, the automatic short-circuiting device operated, the arc was extinguished and the short-circuiting device opened. So far, this was exactly what was anticipated, but no sooner had the short-circuiting device opened and the electromotive force returned to the line and the dischargers, than the dynamo pressure forced an arc across the air gap once more, and the whole operation was repeated. This repetition was found to be due to the fact that when the arc was first established between the carbon saw-tooth plates, the carbons were heated to a white heat, which not having time to dissipate itself before the pressure returned, the dynamo current found a sufficiently easy path over the heated air gap to reestablish an arc. However, the test being otherwise satisfactory, success seemed assured, for all that was necessary now was to use solid metal dischargers that would readily conduct the heat away, and the trouble above cited would no doubt be avoided. So the test was repeated, using the same apparatus as before, except the dischargers, which now consisted of three solid, round, brass rods, one inch in diameter and one and one-quarter inches long, placed side by side with their axes parallel to each other, and having air gaps of $\frac{1}{16}$ inch. That is, the line was connected to the two outside bars, leaving the middle one idle to be connected to ground, as would be the case in a double pole lightning arrester. The air gaps were bridged as before with tinfoil to start the arc, and the switch thrown. The test was successful in the highest degree—too successful, in fact, not to arouse suspicion. So I thought I would repeat the experiment, and see how the dischargers would behave without the short-circuiting device. The result was an overwhelming surprise, for at the dischargers there was merely an insignificant spark, scarcely larger than a pea. The experiment was tried again and again, with the same result. Any electrician would have predicted a brilliant display of fireworks. The most plausible theory advanced to to explain this action was that the electric motor driving the dynamo being small, its speed was probably reduced to such an extent by the overload suddenly thrown upon it that the electric pressure was at once reduced below that which would be necessary to maintain an arc across the air gaps. On second thought, this theory would have seemed improbable, but at the time it was accepted without a question. In a few days a test was again made, this time a small engine being used for motive power, and the same results were obtained as before. The afternoon of the same day both engine and generator were changed with like results. In the meantime a little reflection seemed to indicate that perhaps this strange action was not, after all, due to the slowing down of the motor, but to the possible cooling effect of the metal discharges on the arc.

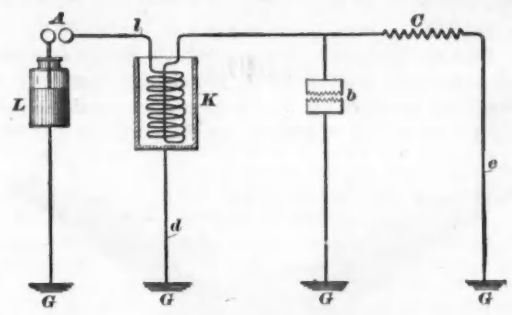
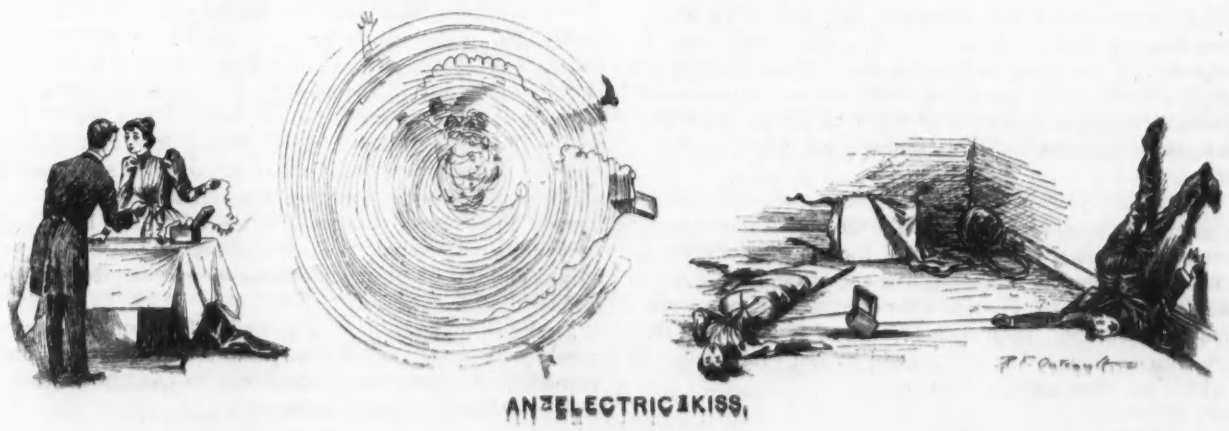


FIG. 8.—WURTS' LIGHTNING ARRESTERS.

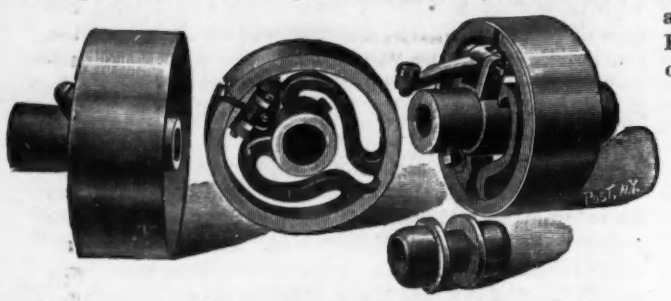
With this idea in mind, I had constructed a set of three dischargers similar to the first, but much larger, $2\frac{1}{2}$ inch diameter by 3 inches long, thinking that if a little metal was good, more would be better, and that perhaps with a large generator the mass of metal would have to be greatly increased to produce the results already obtained. This large discharger was connected to a 3,000-light, 1,000-volt alternator, the air spaces were bridged as before, and the scene which followed beggars description. The large metal bars were melted like beeswax in a great ball of fire. My disappointment was keen, for I thought I was on the verge of making a discovery, and that in the previous cases the comparatively feeble engine had not been the cause of the action. Thinking, however, there could be no harm in melting up the smaller discharger, I connected it in where the larger one had been, bridged the air space, and threw in the switch. Imagine my astonishment on hearing an insignificant snap like the crack of a toy pistol, and seeing an arc as before no larger than a pea. I then pushed a nickel down into one of the air gaps to short circuit it, and leave only one air gap for the arc, and tested again with the same results. Two questions now presented themselves—viz., what were the differences between the large and small dischargers other than size, and why did the small discharger behave in this altogether unlooked for manner? The answer to the first question was readily found by tracing the two dischargers back to their source, and there learning that the larger one of the two was made of cast brass, containing certain proportions of tin and copper, and that the smaller one was made of hard drawn brass, containing certain proportions of zinc and copper.



*A paper read before the American Institute of Electrical Engineers, New York, March 15, 1892.

An Improved Friction Clutch.

The accompanying illustration represents a new improved friction clutch, which has been designed by the manufacturers especially to meet the requirements of screw machine and turret lathe work. By reference to the cut it will be seen that the friction surface proper consists of a spring ring which is caused to expand by the drawing in of a taper bolt; this bolt being operated by the usual finger and sliding cone, the friction ring has no direct connection with the hub, being connected thereto by two curved arms, which extend

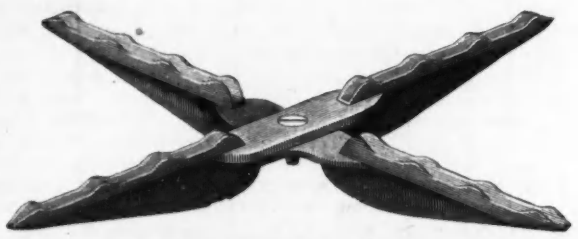


GARVIN FRICTION CLUTCH.

as far as possible to the opposite of the hub. The feature in question greatly increases the elasticity of the ring and allows it to fill in all directions, giving a perfect bearing. Double provision is made for taking up all the wear by means of the usual adjusting screw with set nut on the outer end of the finger, and also by screwing the taper bolt into the nut, which is pivoted to the inner end of the finger. This allows of a readjustment should the clutch wear sufficiently to use the full length of the outer screw, by simply screwing down the taper bolt and returning the outer screw to its original position.

The pulleys are made with long and ample bearings, the inner hub extending inside the friction surface beyond the face of the pulley and being provided with an efficient self-oiling device.

These clutches have withstood the most severe usage, it is stated, and have proven especially serviceable under high speeds and heavy loads, giving a quick and positive reversal with a smooth and easy motion, which latter feature is most important in countershafts which are constantly reversed. They are made in three sizes, and are designed to accompany all of the standard machines having friction



THOMSON-HOUSTON CROSS-OVER.

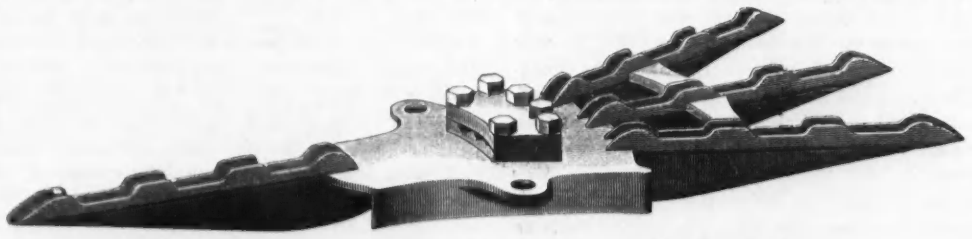
counters. They are manufactured by the Garvin Machine Company, Laight and Canal streets, New York.

Thomson-Houston Standard Switches and Crossings.

In the overhead wires of an electric street railway there must be a switch or frog to correspond to every switch or frog in the track. These overhead frogs must be as light as is consistent with the necessary strength and they must be so constructed as to fulfill their purpose with certainty. The frogs manufactured by the Thomson-Houston company, it is claimed, possess these qualities: they are light and strong, easily put up and certain in their operation. Forms have been designed to meet all the conditions of line construction. We show in the illustrations two forms of these switches and crossings.

The standard frog made in the form of a Y is best suited to most requirements, it is stated, but frogs are also provided for right-hand and left-hand switches, and a three-way frog for double-branch switches. The trolley wire is soldered into the grooves between the clips on the tongues of the switch, and is also firmly clamped by the screws and metal cross pieces on the top of the frog plate. Provision is made at the sides for the attachment of cross suspension wires.

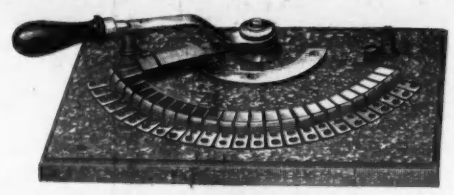
Where two overhead wires cross each other a similar arrangement to the frog is used, with the only slight changes necessary to adapt the apparatus to the different conditions met. Two forms of this apparatus are made, one of acute angle crossings and the other for crossings at an approximate right angle. Both forms are made to swivel, so that the tongues will adjust themselves to the exact angle at which the wires cross.



THOMSON-HOUSTON OVERHEAD RAILWAY FROG.

A Stage Regulator Switch.

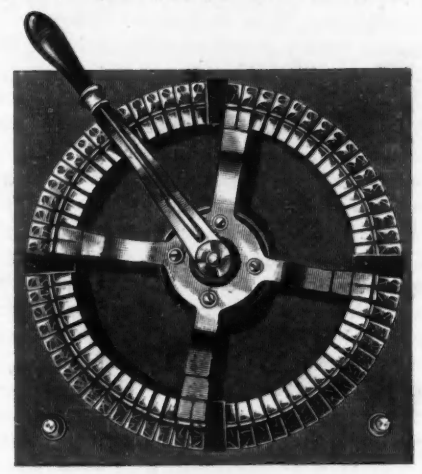
The adoption of electric illumination in theatres and the consequent enhancement of the beauty of the scenic effects obtainable has become very general in this country. At first the effects were crude and inartistic owing to the inefficient apparatus used for controlling the lights. A beautiful sunset effect would be spoiled by the dwindling of the rosy light by jerks, too perceptible to the audience not to cause laughable comment, the opposite result occurred when the increasing light was supposed to represent a sunrise. To obviate these objectionable features, the Edison General Electric Company has recently brought out a new stage regulator switch by means of which gradu-



ORIGINAL STAGE REGULATOR SWITCH.

ations of light are obtained fine enough to satisfy even the most fastidious of stage managers. We show in the cuts the original type of stage regulator switch with the semi-circular row of clips, and, for purposes of comparison, the improved switch with the circle of clips divided into four quadrants.

This switch, mounted on a slate base, consists of 50 clips arranged in a circle in four divided quadrants with a four-armed contact passing over them, and engaging in a clip every quarter width of the clip. Contact over the entire 50 clips is made by a movement of the switch handle through an angle of 45 degrees only, instead of through 120 degrees as in many stage regulators in use, and thus the



NEW EDISON QUADRANT SWITCH.

speed of the operation is considerably increased. These switches are either directly mounted on the sides or the top of the fire proof stage regulators, or separately upon a switchboard and connected with the regulators by means of regular fireproof cables made up of the strands of the connecting wires. They can also be arranged in a special frame in such a manner that the handles can be worked separately, or, connected together, be all operated as one unit.

The Works of the Washington Carbon Company.

In view of the great strides which have been made in the manufacture of carbons in late years, and also on account of the keen competition which has manifested itself among the chief interests in this line of business, a few points relative to the magnificent carbon factory of the Washington Carbon Company may prove very interesting.

This factory is situated in the quaint old town of Washington, Pa., which can be easily reached from Pittsburgh, Pa., by a short ride, either on the Pan-Handle or Baltimore & Ohio railroads. The works are located in the very heart of the most productive oil, natural gas and coke region of Western Pennsylvania, which is a fact worth mention, because it is one of the most favorable advantages for obtaining the very best raw material at the very lowest figures. The works consist of three adjoining buildings containing respectively the milling and molding departments, and the engine, the furnace, the plating, the testing and the shipping rooms.

Equipped with the most improved milling and hydraulic machinery, as well as the latest designs of carbonizers and furnaces, the immense product can be quickly handled, yet absolute uniformity of the goods attained, as the company spares no efforts in perfecting the process of manufacture and upholding the high quality of its product. Natural gas, furnished from neighboring wells, is used throughout the works, for heating, lighting and manufacturing, thus insuring a uniform temperature, and yielding the best results in the quality of goods turned out. Carbons which have passed through the natural gas process, it is claimed, are greatly superior to those that are carbonized by the old artificial process of coal, such as prevails in some carbon works in the country to-day. At present this company manufactures 18 standard sizes of round, flat and oval arc light carbons, besides battery plates and a large variety of carbon specialties, and has just placed a large order for additional machinery for the manufacture of carbon motor brushes. As stated in one of its recent publications, the works of this company have a capacity of 50,000,000 carbons a year, which is as large, if not larger, than any other concern in the same line of business in the country.

Mr. C. W. Wells, the superintendent of the works, is a very genial and courteous gentleman. In running the enormous plant under his control he illustrates a system of operating and conducting the affairs of the factory upon which he deserves the highest congratulations. The testing and experimental department is also very interesting, so ably presided over by the electrician. Mr. L. B. Marks, who has introduced many new features. Mr. Marks is the author of a paper read before the American Institute of Electrical Engineers, in May, 1890, on the "Life and Efficiency of Arc Light Carbons."

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

New York, March 26, 1892.

The market this week has been decidedly strong, but as quiet as it was strong, and the long continued dullness has become even more established than ever. The consideration of the silver legislation has not materially affected the situation, although it was thought that it would have a decided influence and lead to considerable raiding. As this factor has now been removed, there is nothing impending to undermine confidence in the market. Gold exports have also ceased, although sterling exchange still continues high. Therefore the only reasonable prediction is that there will speedily be a most active and buoyant market. The transactions are still confined to a few securities, but there is good strength in nearly all of them. There is no change whatever in the money market, excepting that it may have grown even duller than it was last week. Rates remain the same, nominally 3 to 4 per cent. for call money and 4 to 5½ per cent. for time loans.

The United Electric Securities Company, of Boston, recently made its eighth call, inviting proposals for sale to the company of its 5 per cent. collateral trust sinking fund bonds; $50,000 of its first series, and $100,000 of its second series of said bonds. This call was in order to retire the company's bonds, as has been the custom when sufficiently large sales have been made to make it possible. In response to the call these bonds were received and bought up. The company will issue another million dollars worth of collateral bonds in a very few weeks, back of which are pledged local companies' securities.

Westinghouse has been the most active of the electrics this week. The trust receipts have gained two points, to 19, and the new common stocks three points, to 30½. There have been about 5,000 shares of trust receipts sold, and 1,000 shares of common stock, and on these small sales the price has gradually risen to the highest figures which it has attained for over a year. The brokers are making numerous wagers as to further increase of the price, for the buying orders exceed the supply. The story is credited that German parties are in the market for the stock, in order to secure some combination between the new German company in Chicago and the Westinghouse. However this may be, the stock can still sell at present prices upon the basis of the present business. The present condition of the market on this stock and its future prospects naturally stimulate the hopes of stockholders, but one can hardly judge what will be the final outcome on the intrinsic value of the property. One party looks for a combination with the new consolidated company; another maintains that it will remain an independent company; and with the business now in hand it is expected the earnings will exceed the largest returns which could possibly result from entering the Edison-Thomson-Houston combination. In fact it is stated that if the business of the company continues at its present rate it will earn 12 or 15 per cent. on all its capital stock. The governing committee of the Boston Stock Exchange has decided by vote that all quotations for Westinghouse electric hereafter must be for new stock. The old receipts of the company have accordingly been stricken from the list, inasmuch as the Trust Company refuses to transfer the same. The new stock only can now be quoted at the board, and as only about one-third of this has, up to the present time, been actually issued, the trading in it will, it is stated, be somewhat affected by the action of the governing committee, and an effort will be made to induce the committee to countermand the order. A block of 100 shares of the old stock is equivalent to 60 of the new, and 60 shares being an odd lot, is not as easily sold as a 50 or 100 share lot. An early transfer of receipts for assented stock into the new common stock will be the outcome.

Dividends.—The Fall River (Mass.) Electric Light Company has declared a dividend of one and one half per cent. payable April 1. The Edison Electric Light Company, of Philadelphia, has declared a dividend of three per cent. on $1,000,000 of stock. The New England Telephone and Telegraph Company has declared a dividend of 75 cents per share, payable May 14, to stockholders of record on March 31, transfer books to be closed from April 1 to May 2 inclusive. The Washington and Lincolnton Telephone Company, of Washington, Ga., has declared an annual dividend of 15 per cent. The Salem (Mass.) Electric Light Company pays a dividend of three per cent. April 1. The Saco River Telegraph and Telephone Company, of Portland, Me., has declared a semi-annual dividend of 2½ per cent. payable on and after April 1.

Stock Listed.—The stock of the Northwest Thomson-Houston Electric Company has been listed on the Boston board. The company was organized under the laws of Minnesota, and its headquarters are at St. Paul. Its capital stock is $1,253,600, of which $750,000 is common and $503,600 preferred. The authorized issue of the former is all out, but there is $246,400 of the latter that can be put out.

Western Union.—It is stated that the net earnings of the Western Union Telegraph Company will be at least $100,000 more than the Executive Committee allowed in its statement and the company, it is said, is making in the poorest period of the year about 9 per cent. on the stock.

Increase in Capital Stock.—The present capital stock of the Bell Telephone Company of Canada is $2,000,000, the whole amount of which has been subscribed, and $1,957,640 paid up and invested in connection with the company's undertakings and operations. The company is desirous of increasing its capital stock to $4,500,000, and a petition praying for a private bill to that effect has been laid before the Dominion House.

The Net Earnings of the Commercial Cable Company for the last fiscal year were $1,085,325, the gross $1,904,717.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, March 26, 1892, in New York, Boston and Chicago:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co	100	86,200,000	87¼	87⅝
Commercial Cable Co	100	7,716,000	150	152½
Edison General Electric	100	15,000,000	96½	97
Edison Illuminating Co., of New York	100	4,500,000	81½	82½
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
" " " " bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co	..	500,000	20	40
East River Electric Light Co	100	1,000,000	....	60
North American Phonograph Co	...	6,600,000	4½	6
New York Phonograph Co	...	2,000,000	3	4
Automatic Exhibition Co	...	2,000,000	2	2½
New England Phonograph Co	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	59¾	58½	58½	59
Thomson Houston Elec. preferred	25	4,000,000	29	28½	28⅝	28¾
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8¼	8¾
Thomson-Houston Elec.—Series D	sh	120,000	....	....	7⅞	8
Thomson-Houston Int'n'al Elec	100	600,000	....	....	200	225
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	105
Thomson Elec. Weld	100	1,000,000	....	....	55	60
Thomson European Elec. Weld	100	1,500,000	....	....	11	12½
Westinghouse Elec.—New Com.	..	6,000,000	30½	27½	29½	30
Westinghouse Elec.—Pfd.	..	4,000,000	44	...	45	46
"Trust" receipts	..	10,000,000	19	17	17½	18
Fort Wayne Elec	25	4,000,000	13¾	12⅞	13	13¼
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	....	7½	7⅝
Detroit Elec	10	1,000,000	8	7¾	7⅞	8
West E. & St. Ry. Co.—Com	50	7,150,000	75⅛	74¾	74¾	75
West End St. Ry. Co.—Pfd	50	6,400,000	66¾	....	86½	86¾
American Bell Tel	100	15,000,000	206	203	205	206
Erie Tel. & Tel. Co	..	4,800,000	46	....	45¾	46½
Mexican Tel. Co	10	1,280,000	1 10	....	1.00	1.10
New Eng. Tel. & Tel. Co.	..	10,304,600	52	....	51	....
Tropical Tel. Co	10	400,000	40c.	...	40c.	....

CHICAGO QUOTATIONS

Chicago	$219@	$220	Cumberland	$60@	$62
Central Union	55¼	56½	Wisconsin	118@	120
Michigan	81@	83	Bell of Missouri	175@	180
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri & Kansas	51@	53
Rocky Mountain Bell	40@	43			
Chicago Arc Light and Power	84@	90	Chicago Edison Co	@	154

NEW INCORPORATIONS.

The Omro Electric Light and Power Company, of Omro, Wis., capital stock $5,000, has been formed to produce and furnish electric light and motor power. The organizers are C. S. Douty, W. W. Race, H. C. Scott, M. Phillips and E. Dennis.

The Electric Railway Construction Company, of Jersey City, N. J., capital stock $50,000, has been formed to construct and repair and equip railways. G. L. Wiley, Arlington, N. J.; R. C. Carhart and W. H. Browne, of Brooklyn, are the organizers.

The Delafield Construction Company, of Jersey City, N. J., with a capital stock of $100,000, has been formed to build and equip railways and electric light works, etc. The incorporators are T. Delafield, W. G. Cook, of New York city, and R. N. Billings, of Passaic, N. J.

The Electrical Piano Company, of Newark, N. J., with a capital stock of $300,000 has been formed to manufacture, rent and sell electrical attachments for pianos and other musical instruments. etc. J. Stahl, L. Schiff, J. Schoenhaur and F. A. Field Kamp, of Newark, are the incorporators.

The Western Investment Company, of Seattle, Wash., with a capital stock of $300,000, has been formed to construct, operate and own cars, electric light, telegraph and telephone lines, etc. R. C. Elliott, Frank Shelberg, of Seattle, and John D. Boyd of West Duluth, Minn., are the incorporators.

The Tower Electric Light and Telephone Company, of Duluth, Minn., capital stock $60,000, has been formed to manufacture and sell electric current for light, heat and power, and to erect telephone lines, etc. G. H. Claypool, A. C. Batchelor and E. C. Jones, all of Duluth, are those interested.

The Spring Garden Mining Company, of San Francisco, Cal., with a capital stock of $1,000,000, has been formed to develop and operate electric power plants, etc. J. W. Shanklin, E. S. Shanklin, of Oakland, Cal.; J. H. Widber, A. C. Widber, of San Francisco, and C. R. Thompson, of Quincy, Cal., are the promoters.

The Fremont Electric Light and Power Company, of Manitou, Colo., capital stock $50,000, has been formed to build and operate a plant to furnish electric light, heat and power to the town of Fremont. The promoters are Ed. P. Creighton, M. A. Leddy, of Colorado Springs, and Col. H. H. Brown, of Denver, Colo.

The Elmira Municipal Improvement Company, of Passaic, N. J., capital stock $1,000,000, has been incorporated to build and equip an electric light plant. F. H. Mollenhauer, Jersey City; H. S. Roll, Hoboken; H. P. Doremus, Passaic; D. C. Robinson, C. H. Baldwin, G. Brand, Elmira, N. Y., and J. B. Woodward, of New York city, are the incorporators.

The San Francisco & West Shore Railroad Company, of San Francisco, Cal., capital stock $1,000,000, has been incorporated to build and operate street and other railways by electricity or otherwise from San Francisco to Half Moon Bay, a distance of 30 miles. H. W. Westphal, C. O. Swanberg, Louis F. Dunand, J. W. Ellis and J. O. Jephson, all of San Francisco, are the promoters.

The Kingston City Electric Railway Company, of Kingston, N. Y., has been incorporated, capital stock $175,000, to build a street railroad to be operated by electricity in Kingston. The directors are Edward T. Stelle, E. H. Loughron, C. W. Deyo, W. Scott Gillespie, E. G. Lawrence, A. E. Winne, Robert Wilson, George J. Smith, of Kingston, and Jansen Hasbrouck, of Rondout.

The National Electric Protector Company, of Memphis, Tenn., has been incorporated with a capital stock of $600,000. The incorporators and officers are J. S. McTighe, president; E. L. McGowan, first vice president; F. Ozanne, second vice-president; J. C. McIntyre, secretary and treasurer; Dabney Scales, attorney; I. L. McKee, Michael McTighe, John S. Toof, A. L. Creelman. The company has been formed for the purpose of manufacturing an instrument which will cut out any open telegraph key, being automatic in its working, and will enable the operator in New York to cut out all other offices to Chicago, except the office wanted. This is for the purpose of secrecy. Should any office cut in the annunciator attached thereto instantly notifies the sender, who can again cut him out, and can also cut in again at pleasure. The instrument will work on a single, duplex, quadruplex, phonoplex or analogous circuit, it is stated, and by means of it an operator in New York can remove a ground wire in Chicago or San Francisco, or can ring any gong desired, or if there is no circuit the gong is rung automatically. These instruments are three inches long, and can be used to replace the present relay if desired.

AFFAIRS OF THE COMPANIES.

The Commercial Cable Company had its annual meeting March 21. The old board of directors was re-elected. The earnings for the year were $1,904,717.01, and the working and other expenses were $819,392.43, leaving a balance of $1,085,324.58. Seven per cent. in dividends was paid on a capital of $7,716,000.

The Fall River Electric Light Company, of Fall River, Mass., at its recent annual meeting elected the following officers: President, Frank S. Stevens; clerk and treasurer, Owen Durfee; directors, Frank S. Stevens, John D. Flint, W. H. Hathaway, E. S. Anthony, O. S. Hawes, F. O. Dodge, R. W. Bassett.

The Metropolitan Electrical Corporation has recently organized with offices at 415 Whitney Building, Kansas City, Mo., for the purpose of doing a general electrical engineering business, acting as consulting and contracting electrical engineers, as western agents for railway equipment, electric lighting and power plants, and contracting for the installation of electrical mining machinery, etc.

The Saco River Telegraph and Telephone Company, at its recent meeting in Portland, Me., elected the following officers: President, Hon. Mark P. Emery; vice-president, J. R. Libbey, secretary and treasurer, John Berryman; superintendent, Freeman Palmer. It was voted to complete the construction of the line to connect with the Limington and Cornish Line, and sell 50 shares of stock to pay for the same, par value $10.

The Fort Scott Rapid Transit Company, of Fort Scott, Kan., has been reorganized and a new board of directors elected. The following are the present officers: President, H. H. Andresen; secretary, F. H. Griggs; vice president, A. W. Walburn; treasurer, J. Lorenzen; assistant secretary, Charles Nelson; assistant treasurer, C. H. Osbun. Many new improvements have been decided upon, the track is to be improved and the general accommodations increased.

The Westinghouse Electric Company, it is stated, during the first half of March took orders for immediate and future delivery of railway equipment and lighting apparatus aggregating nearly $1,000,000, which have come from all parts of the country. The company is said to be doing a remarkably large business, its earnings are increasing, and its improved prospects are a source of gratification to those, especially, who have recently become interested in it financially since the reorganization. Most of the sales made by the company have been on a cash basis, which serves to place its finances in excellent condition. The recent order received from the Brooklyn, N. Y., Street Railway Company is an extensive one, and includes a large portion of the equipment of these lines.

The Thomson-Houston International Electric Company, whose headquarters have been at Hamburg, Germany, has transferred its European business to the Union Elektricitäets Gesellschaft, of Berlin, who will hereafter conduct the business of that company in Germany, Austria, Hungary, European and Asiatic Russia, Finland, Sweden, Norway, Denmark, Holland, Belgium, Switzerland, Turkey and the Balkan States. The former manager at the Hamburg office, Mr. Louis I. Magee, will have charge as technical director in this new company. The directors of the company are Louis I. Magee, Max Rosegarten and F. W. Vortmann. Their headquarters are at Hollmannstrasse No. 32, Berlin, S. W. Among their specialties are electric lighting, with direct as well as with alternating current systems, electrical transmission of power, mining machinery, and particularly the building of electric railways.

The Short Electric Railway Company held its annual meeting in Cleveland March 17. The following directors were elected: Sidney H. Short, Myron T. Herrick, J. Potter, John S. Bartlett, James Parmelee, Eugene Griffin and William B. Bolton. The directors met and elected the following officers for the ensuing year: J. Potter, president; S. H. Short, vice-president and chief electrician; Charles B. Lothrop, secretary and treasurer; E. E. Higgins, general manager; William B. Bolton, general counsel. Mr. S. H. Short, who from the organization of the company has been its president and chief electrician, was renominated for the presidency, but declined to accept the position, owing to the fact that the growth of the company had made the duties of president so onerous as to seriously interfere with his technical work and inventions to which he desired to give his undivided attention, and in consequence he asked relief from his general business cares.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, March 28, 1892.

Messrs. Truex & Vail have removed from the sixth floor to room 414, fourth floor, Electrical Exchange Building.

Mr. Henry Alexander, the treasurer of Alexander, Barney & Chapin, has tendered his resignation and severs his connection with the company April 1.

Mr. F. L. Perine, formerly of the Engineering Equipment Company, of New York, it is reported, has plans in view which will be of interest to the trade.

The cost of lighting Brooklyn last year was $493,000, of which $285,000 was for electric lights. The budget of 1891 appropriated for this year for lighting the city $530,000.

The General Electric Company.—The bill introduced in the Senate by Senator Cantor to incorporate the General Electric Company was laid over after discussion, for amendment.

The Manhattan Electrical Supply Company will occupy the store at 32 Cortlandt street in addition to their present quarters after May 1. This move is made necessary by the enormous increase in their business during the last few months.

The New York Insulated Wire Company has just closed a contract with the Southern Bell Telephone Company for 164,000 feet of conduit tubing to be laid in Atlanta, Ga., and also a contract with the Bell Company, of Canada for 100,000 feet of the same tubing.

The Electric Construction and Supply Company, of 18 Cortlandt street, have just installed 22 "Ward" lamps in the establishment of Hines, Ketcham & Co., Brooklyn, and 30 of the same in the great packing house of Geo. K. Fowler, Son & Co., Kansas City.

The American Institute of Electrical Engineers, through its secretary, Mr. Ralph W. Pope, is sending out Volume 8 of the Transactions of the Institute, for the year 1891. The volume is neatly bound and compiled and contains the complete report of the monthly transactions of the society.

Mr. C. S. Pease, formerly with the Westinghouse Electric Company, and later with the Washington Carbon Company, is now superintendent of factories of the Interior Conduit and Insulation Company, Thirty-fourth street, this city. Mr. Pease is a hustler and will make a valuable acquisition to the forces of the conduit company.

Eighth Electrical Execution.—The eighth execution under the laws of this State took place to-day at Sing Sing, when Jeremiah Cotto was executed for murder at 10:45 A. M. A new chair was used, and five contacts were necessary, each lasting 12 seconds. The electrodes were attached to the forehead and at the calf of the leg.

Messrs. Doubleday, Mitchell & Co., the well-known supply dealers, will remove on April 1 to the Electrical Exchange Building (rooms 217 and 218), 136 Liberty street, this city. In addition to handling a general line of supplies, and acting as agents for the well-known Columbia lamp, they will hereafter handle exclusively in this territory the celebrated "canvas jacket" wires and conduits.

Mr. Joseph Lee, for the last 10 years with the Edison Illuminating Company, this city, has opened a general electrical repair shop at 2, 4 and 6 Reade street, where he is fully equipped to furnish all parts of standard motors or dynamos, carbon and copper brushes to fit all machines, rewinding of armatures, turning off or making new commutators, in fact make, renew or repair all kinds of electrical work.

The Bill for an Electrical Commission for West Troy has passed the Senate. The measure provides that the village president shall appoint a board of five commissioners, who shall direct the management of the electric light works of the village, the appointment to be made within 20 days after the signing of the bill by the Governor. Each year the commission will be allowed not to exceed $8,000 to conduct the works.

The Board of Electrical Control met in the Mayor's office, March 25, and ordered Engineer Kearney to prepare plans for the work to be done this year. Subways will be built under all streets that are repaved this year, where subways have not already been placed. The engineer was also empowered to plan out another district, No. 4, from which overhead wires and poles are to be removed as soon as the subways are ready.

The Engineering Equipment Company, Central Building, New York, at a meeting held Saturday, March 19, elected the following directors: A. L. Tinker, F. H. Underwood, C. A. Tinker, F. A. Magee and E. L. Harriot. The following officers were then elected: A. L. Tinker, secretary and treasurer; F. A. Magee, general manager. W. F. D. Crane was appointed manager of the railway department, and C. S. Merrill manager of the belting department.

Thomas F. Stevenson, receiver of Stanley & Hall, has called a meeting of the creditors of the late corporation of Stanley & Hall to be held at his office 15 Cortlandt street, on May 25, at 2 P. M. when all accounts and demands for and against such corporation and its estate shall be fairly adjusted as far as the same can be ascertained, and all demands for and against such corporation and all its open and subsisting contracts shall be ascertained and adjusted so far as may be, and the moneys in the hands of the receiver declared.

A Subway Commission for Brooklyn.—A bill recently introduced into the New York Legislature by Assemblyman O'Connor provides for the appointment of a Subway Commission for Brooklyn similar to that of this city, the object of which is to cut down poles, bury electrical wires and exercise supervision thereof. In accordance with the provisions of the bill the Commission is to consist of two "disinterested" persons, each to receive an annual salary of $4,000, who will be authorized to employ a sufficient staff of clerical and expert assistants to aid in accomplishing the work of burying the wires.

An important consolidation of the manufacturers of some well known insulating materials has just been consummated between the Johns-Pratt Company, of Harford, Conn., and the Gould & Watson Company, of Boston. The Johns-Pratt company is the manufacturer of vulcabeston, an insulating material now used in very large quantities by all the prominent electrical companies in the country, while the name of the Gould & Watson Company is a familiar one in connection with the molded mica insulation so extensively used in electric railway construction material. These two interests are now combined and the business will be conducted by The Johns-Pratt Company. The product of the consolidated company will cover every requirement for electrical insulation. Mr. C. Tennant Lee, the inventor of molded mica, will be the consulting chemist of the company, and the H. W. Johns Manufacturing Company, 87 Maiden Lane, New York, with branches at Chicago, Philadelphia, Boston, Atlanta and London, will continue to be the selling agent as formerly.

Hearing on the Telephone Bills.—The Assembly Committee on gas, electricity and water gave a hearing on the afternoon of March 23 on the bill of the Telephone Subscribers' Association of the city of New York to reduce the rental of telephones and the tolls. There are two bills—one introduced by Mr. Rice, of Ulster, and one by Mr. Cahill, of Kings—both designed to accomplish the desired result, and another bill, the Blumenthal measure of last year, which provides for the appointment of a commission to fix rates, and which was introduced by Mr. Malone, of Brooklyn. A large delegation appeared from New York, and arguments were made in favor of the measure. Assemblyman Malone requested that the committee take action at once. Chairman Martin asked if he did not think that the opposition to the bill should be heard, and Mr. Malone said he did not, as the bill did not reduce rates, but appointed a commission. The committee will report the bill for a place on the calendar and have it recommitted for a hearing on Wednesday of this week, when the telephone companies will present their arguments against it. The Telephone Subscribers' Association and the Board of Trade, however, are preparing to send another large delegation to Albany to watch the proceedings and argue in favor of the bill if called upon at the hearing Wednesday.

L. H. H.

PHILADELPHIA NOTES.

Branch Office of The Electrical World,
927 Chestnut Street, Philadelphia, March 26, 1892.

Gill & Co., manufacturers of globes and shades for electric lighting, report a growing demand for their goods.

H. T. Paiste states that he is meeting with an active demand for his many varieties of china and porcelain goods.

The Philadelphia Electrical Supply Company reports an active demand for the Wirt brush in this territory.

Alfred F. Moore reports meeting with an active demand for his well known insulated electric wires and flexible cords and cables.

T. Yearsley has an exceptional stock of second hand dynamos and supplies, probably the best assorted lot that can be found south of New York.

The Star Electrix Company will shortly have something to interest the electric trade, as they are about to manufacture several new specialties.

The Appleton Manufacturing Company, Myrtlewood street, builders of grinding machinery, would be pleased to give quotations for their various machines to parties inquiring.

Pepper & Register report business in the electric field as being very encouraging. They are working on several contracts at present, which, when completed, will reflect credit on themselves.

The Howard Foundry and Machine Works manufacture sweepers that are admirably adapted to street railway purposes, and also elevators designed for freight and passenger purposes.

Otis K. Stuart since his arrival in Philadelphia has every reason to feel satisfied with the way that the electrical fraternity in Philadelphia and vicinity have taken hold of his various specialties in the electric line.

Queen & Co., the well-known electric instrument company, are constantly introducing new instruments adapted to all branches of the profession. They carry probably the largest stock used in this line of any house in the world.

Pedrick & Ayer, manufacturers of all types of machinery for electric specialties, and also mining machinery and milling machinery, are in a position to supply machines on the shortest notice, and would be glad to hear from any needing anything in their line.

The Imperial Electric Company reports that business is decidedly on the increase. The prospect for spring trade seems very bright and they are very hopeful of doing a largely increased business. They find an active demand for their porcelain goods.

The Century Pottery Company, Camden, N. J., has received recently a large order for its different manufactories from Buffalo, N. Y. They also report heavy business in their specialty line. They intend very soon to enlarge their works and will branch out in every line of this industry.

Haines, Jones and Cadbury Company, manufacturers of the blast furnace for linemen's use, are offering a first class article for this purpose. Its points of advantage are that it is thoroughly practicable for such use, besides being of such a size that it can easily be conveyed from place to place.

John L. Gill, Jr., is sole representative of the Gill patent water tube steam boiler. The point urged why steam users should obtain this boiler is economy in fuel, because it occupies little space, all parts are accessible for examination and cleaning and it has all the properties required in the best steam generator.

Thomas H. McCollin & Co. report the introduction of a new article very important to draughtsmen. This is specially prepared linen-coated like the ordinary blue print paper, for making blue prints directly on the linen surface. This dries out flat and can be folded or creased without injury. Its superior strength for working or shop plans, where much handling is required, can readily be seen, and the price is almost as low as the paper. The working of this linen is very simple, requiring only printing in a printing frame and washing in water. This is having a large sale among practical machinists and designers.

The large line of arc light globes and incandescent shades manufactured by J. J. Murray & Co., of this city, makes them a leading house in the production of these articles. Their globes and shades are made of the purest material, it is claimed, and, being strong and symmetrical, they are used by prominent electric light plants throughout this country as well as Canada and foreign countries. Their new illustrated catalogue contains an almost endless variety of shapes and styles, from the very cheapest to the highest prices, in etched, engraved, fine cut, and other effects.

W. R. W.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., March 26, 1892.

The Thomson-Houston Electric Company will hold its annual meeting Monday, April 11, at 1:15 P. M., in Middletown, Conn.

Shleicher, Schumm & Co., of Philadelphia, engineers and builders of the Otto gas engine, have opened an office in this city at 19 Pearl street.

Mr. F. A. Magee has been appointed New England agent for the Bishop Gutta Percha Company. Stock will be carried at 126 Pearl street, this city.

Death of Mr. E. H. Woodman.—We regret to announce the death of E. H. Woodman, general manager of the Concord Gas and Electrical Company, who was well and favorably known among the electrical people of New England.

The Bryant Electrical Company, of Bridgeport, Conn., still continues to have a steady sale for its well known specialties. The fact that all orders received are given attention at once and promptly shipped is appreciated by customers, as the numerous duplicate orders received attest.

Westinghouse Electric Company.—Mr. R. S. Brown, northeastern agent, has just closed a contract with the Fitchburg (Mass.) Street Railway Company for their entire electrical equipment, consisting of two 150-h. p. multipolar generators and eight car equipments of two 20-h. p single reduction motors each.

The Fitchburg (Mass.) Street Railway Company and the Leominster Street Railway Company will be consolidated April 1. Three and a half miles of new track will be built and eight new cars will be put in operation, furnished with Westinghouse motors. W. W. Sargent, at present superintendent of the Fitchburg line, will have charge of the building and equipping.

Mr. C. F. Dow, superintendent of the Somerville (Mass.) Electric Light Company, will resign his position April 1, and will be in the future engaged in the electrical department of the West End Street Railway Company, of this city, under Superintendent L. S. Dumoulin. His position with the Somerville Company will be filled by Mr. Frank A. Batchelor, late of the Thomson-Houston Company.

The West End Street Railway Company will hold an important meeting soon, it is stated, at which it is possible, says the Boston *Traveller*, the question of issuing the new stock may receive consideration. A statement of the financial requirements of the road during the next six months will, it is understood, be presented thereat. The aggregate amount that will be needed is said to be between $2,000,000 and $3,000,000. Of this sum it will take $500,000 or more to pay for 500 new motors, which are to be furnished by the Thomson-Houston people during the summer, and it will take as much more for the cars themselves. Then there will be the cost of properly equipping the Charlestown division for the electric service, a large amount of new rails, new construction, etc. The sale of 40,000 shares of new stock by auction will provide not only the required amount, but will also give a handsome surplus besides to be used for future improvements and extensions as the same may be decided upon.

C. A. B.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, March 26, 1892.

Mr. F. S. Terry was called East on a flying trip Monday afternoon.

Prof. H. S. Carhart, of the University of Michigan, passed a few days in Chicago this week, arranging matters in general prior to an extended trip to Europe.

Rewinding Armatures.—The Rockford Electric Manufacturing Company, of Rockford, Ill., make a specialty of rewinding armatures and making other repairs to electrical machinery.

Mr. J. C. Liggett, formerly with the Edison Electric company in Milwaukee, has been appointed Inspector of the Michigan Insurance and Inspection Bureau, with headquarters in Detroit.

The Eddy Electric Manufacturing Company, of Windsor, Conn., has made an offer to the directors of the World's Fair to put in an electric plant free. They propose to put in a 300 h. p. plant free of cost.

Foreign Electrical Exhibits.—Space has been allotted to foreign countries in the electricity building, and approved by the Director General. The allotment of space for exhibitors in this country will be concluded within 30 days.

Mr. C. O. Baker, Jr., of Newark, N. J., called on his many friends in Chicago this week, transacted a goodly amount of business and left behind the cheering impression that business would be better than ever during the coming months.

Progress of the Electricity Building.—The framework for all the towers up to the main entrance line of the Electricity Building is now completed. About one-third of the gallery floor has been laid and the roof boarding completed over all the gallery trusses.

Special Electric Fixtures.—The Chicago Gas & Electric Fixture Manufacturing Company, 47 South Jefferson Street, Chicago, is supplying the trade with electric bracket and ceiling fixtures of new, unique and attractive designs that are especially suitable where something out of the ordinary line is desired.

The Progress of Light.—The electrical department of the World's Fair is in receipt of a design for a panel in bas-relief illustrating the progress of illumination. It is the work of J. C. Tate, of Des Moines, Ia., and has four figures. The first represents Age with his tallow torch extinguished. A miner typifies the epoch of oil illumination, and a contrasting figure is designed for the era of the introduction of gas, while Youth holds the electric light aloft.

Electric Launches.—Bids for the launches on the lagoons at the World's Fair will be considered at a joint meeting of the Committee on Ways and Means and the Committee on Grounds and Buildings next Monday at 4 o'clock. Nothing was done at the meeting yesterday. It is understood that electricity is favored as a motive power, and it is stated that the bid will be awarded to the Electric Launch Navigation Company, of New York, which offers to give 33⅓ per cent. of its total receipts.

An Arc Lamp for Incandescent Circuits.—An improved and simplified form of the Nutting arc lamp originally described in The Electrical World of April 26, 1890, is being placed on the market by the Nutting Electric Manufacturing Company, of 10 East Van Buren street, Chicago, orders for several hundred being already booked. On arc circuits the lamp has proved a success from the start, even under the widest range in temperature, and during a test covering nearly two years on incandescent circuits it is reported to have maintained its proper length of arc under varying conditions. Again it is reported to have operated as satisfactorily on alternating current as on constant potential current circuits.

The question of electrical arc lighting in the Exposition grounds has been decided by the Committee on Grounds and Buildings, with the result that the 5,000 or 6,000 lights required will be secured at $20 per lamp. The Thomson-Houston company, which in a former bid asked £38.50 per lamp, lowered its price to $20, and it was given 3,500 lights. One thousand lamps were given to the Standard Electric Company, of Chicago, and the remaining lights are to be furnished by foreign concerns. Under the contract the electrical concerns will not be required to furnish the services of an expert to set the machinery up. It is stated that the Thomson-Houston Company will distribute its contract for 3,500 lights among the Brush, Fort Wayne, Schuyler and Excelsior companies. The contracts for 80,000 incandescent lights are yet to be made.

Four Electrical Machines are to be set at work in the Chicago Post Office, and electricity will cut a very large figure in the handling of letters next month. Acting Postmaster Hubbard has received notice from the Postmaster-General to the effect that the Chicago Post Office had been allowed four stamping machines for stamping postmarks and canceling stamps on letters. These machines will be received in a few days, and when put into position and set at work, each machine will cancel 28,000 letters per hour. The motive power is electricity. The four machines will perform the work of 16 men. A feature of the machine is that it makes a perfect postmark, and people receiving letters stamped by these machines will have no difficulty in reading the postmarks. The department has contracted for 100 of the machines, and they will be distributed among the large post offices of the country. Greater economy and more satisfactory service, it is claimed, will be the result of the introduction of the machines.

The Electric Exhibit.—In a recent issue the Chicago *News* had the following, which voices the sentiment of all who are interested in the electrical feature of the World's Fair: "It is to be hoped that no discord between the World's Fair managers and the electric light companies in regard to the cost of lighting the grounds will be allowed to interfere with the completeness of the general electrical exhibit. If there is any field of modern invention and progress that can be called truly American it is the practical development of electricity. Here we outrank all the nations. American inventors and scientists have given to the world new uses for electricity that have revolutionized many spheres of human labor. They have perfected the telephone, the phonograph and the new transmitters used by telegraphers. In electric lighting and electric propulsion they have outstripped all competitors. No World's Fair exhibit can compare in utilitarian interest to mankind with the electrical exhibit. A large portion of the intelligent public has come to believe that electricity is the force that will rule all spheres of human activity in the future. They are intensely interested in every new use to which the subtle agent has been put."

The Chicago Electric Club held its regular meeting on Monday evening, when the members listened to interesting and instructive remarks on the subject of "One Motor for Car Equipment," from Mr. Elmer A. Sperry, who was followed by Mr. W. L. R. Emmett, of the Edison company, with remarks on the application and efficiency of "Two Motors for Car Equipment," after which a vote of thanks was tendered to Mr. Sperry and Mr. Emmett. In view of the small average attendance at the meetings during the present season the question naturally arises, "Do the members really appreciate how earnestly Mr. F. S. Terry had labored to secure interesting papers? how many hours he has devoted to this work that could have been more profitably spent in advancing his own interests? how often he has supposed that matters have been satisfactorily arranged for a creditable meeting, and then at the eleventh hour been informed that "matters of importance" prevented the appearance of the gentleman announced to read the paper of the evening? Then how he has been compelled to drop all his own affairs, no matter what amount might be involved, and hustle around to find some one whose loyalty to the club is not buried under a mass of business affairs, and who is willing to contribute of his time and talent taken from his busiest moments to advancing the best interests of the club? If the club members will but look at this question from the right point of view they will esteem it a privilege to indicate their high estimation of Mr. Terry's excellent work as chairman of the literary committee, by turning out in full force at every meeting of the club, and affording all the personal encouragement possible. And unless this is done at once the literary meetings of the club will be few and far between.

F. De L.

Tacoma, Wash., March 19, 1892.

J. W. Gabriel has resigned his position as superintendent of the Tacoma Railway and Motor Company.

The Seattle Consolidated Electric Railway Company has rearranged its lines and improved its service.

Mr. Tibbetts, of Seattle, succeeds G. W. Gabriel as superintendent of the Tacoma Railway and Motor Company.

The Union Electric Company, of Seattle, is extending its commercial circuits out Madison street. New orders for municipal lights are coming in rapidly.

Chas. H. Baker, manager of the Seattle agency of the Short Electric Railway, has returned from the East, having visited Cleveland, O., Chicago and New York.

Mr. Paul Winser, traveling representative of the Westinghouse Electric and Manufacturing Company, was recently in Tacoma on electric railway business.

Mr. E. B. Kittle, of Seattle, representing the Northwestern Thomson-Houston company, was recently in Tacoma in the interests of his company's street railway system.

Frank Jaynes, superintendent of the Pacific division of the Western Union Telegraph Company, who visited Seattle on business connected with the telegraph injunction suit, has returned to San Francisco.

The Duwamish Construction Company was recently incorporated in Seattle by Angus Mackintosh and others. Its purposes are to build suburban electric railway lines on which trains will be capable of making 40 miles an hour. The locations of the proposed lines and the equipment to be used have not been divulged.

The Tacoma Light and Water Company, C. B. Hurley, general superintendent, has made an agreement with the Commercial Electric Light and Power Company, whereby the latter is to cease to extend its arc lighting system in future, the former company in turn leaving the incandescent lighting field, as to future extensions.

The Washington Electric Company, of Seattle, A. E. Braymer, manager, which recently started up in its new central station on Lake Washington, using the Thomson-Houston alternating system, has the following officers: Fred. E. Sander, president; E. B. Kittle, vice-president; A. E. Braymer, secretary and manager; Chas. Lovejoy, treasurer.

Snohomish Capitalists, headed by Mayor Ferguson, are pushing the construction of an electric railway, to connect that city with Everett, Wash., via Lowell. The line will be about eight miles in length. The contract for a $30,000 iron bridge across the Snohomish River at Everett has been awarded to the Washington Bridge Company, Tacoma.

G. R. De V.

ENGLISH NOTES.

London, March 19, 1892.

Liquid Oxygen Experiments.—At the last general monthly meeting of the Royal Institution donations were acknowledged to the extent of nearly £450 to assist in carrying out any further experiments in regard to liquid oxygen.

Underground Telegraph Wires.—The interruptions to which the telegraph system of this country is liable during the average English winter is giving rise to agitation for underground telegraph wires between our chief industrial centres.

Coast Communication.—From the speech of the president of the Board of Trade, at a meeting last week of the Associated Chambers of Commerce, it may be taken as settled that the government will give every support to a scheme for an organized system of coast communication, with branch cables to lighthouses and lightships.

Cost of Lighting the House of Commons.—It is anticipated that the cost of lighting the House of Commons for the ensuing financial year will be £6,550. Of this total electricity is debited with £1,800, gas with £3,200 and oil lamps with £1,550. Taking the Board of Trade unit at 7d., an £1,800 bill would mean some 61,000 kilowatt hours.

Cooking by Electricity.—Messrs. Crompton & Co. give at the Crystal Palace daily exhibitions of the varied applications of electricity to domestic purposes. The chief centre of attraction is their exhibition of electric heating. For the purpose of heating Messrs. Crompton employ kettles, saucepans and other domestic utensils coated with a special enamel in which the incandescent wire is imbedded.

The National Telephone Company.—The National Telephone Company continues to justify its facetious title of the "Telephone Absorption and Maintenance Company." Last week it was announced that the recently formed Caledonian Telephone Company would be taken over by the National Company, and this week the same news is announced with regard to the Sheffield Telephone and Electric Lighting Company, which for many years has sturdily and successfully fought the National Company in Sheffield.

Fatal Electric Lighting Accident.—Considerable notice has been taken in the daily press of a fatal accident due to high

pressure electricity, which took place last week at Chatham. It seems that some difficulty having occurred in the circuit of a shop in that town, the supply company's workmen were called in to see it and one of them slipped and inadvertently caught hold of the leading-in wire and received such a severe shock that he is now in a critical condition. According to the evidence at the coroner's inquest, a shop assistant next observed that the transformer "was emitting sparks" which he proceeded to beat out by means of an iron bar, with the result that he was killed.

The Telephone Question.—The Associated Chambers of Commerce, like almost every other public body, passed a resolution last week calling upon the government to take over the telephone system and work it energetically. The three telephone bills now before Parliament, viz., that introduced by the government itself and the two fathered by the National and New Telephone companies will be considered together by a special committee of the House of Commons, and we may expect in the next few months, if not weeks, a public and definite pronouncement as to what the government proposes to do in the matter.

Municipal Electric Lighting.—An announcement which appeared last week in daily paper, to the effect that the St. Pancras Vestry had withdrawn its Parliamentary bill, asking for powers to raise the sum of $360,000 for carrying out the electric lighting of the entire district, gave rise in some quarters to the rumor that the Vestry had already tired of electric lighting. The chairman of the electricity committee of the Vestry has however written to correct this erroneous impression, pointing out that the bill was necessitated by some difficulty between the Vestry and the London County Council with regard to the mode of raising the money required, and this difficulty having now been overcome, there was now no need for a Parliamentary bill. The chairman of the committee states that the electric lighting in St. Pancras is an assured success, that the public lighting will shortly be further extended, and that new customers are coming in almost daily. The Vestry supplies current at 6d. per Board of Trade unit, as against the 7d. and 8d. charged in other parts of London.

Inquiries from Correspondents.

Queries to be inserted in this column must be of general electrical interest, and must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. No notice will be taken of questions which involve nothing more than can be found in elementary treatises on the subject. All correspondence should be as brief as is consistent with clearness. Readers are invited to send discussions and answers to these questions, which will be inserted in the column below.

[15.] Are iron trolley poles any more dangerous than those made of cedar? H. S. W.

[16.] How many ampères are required to heat a No. 16 steel wire to a temperature of 1,200 degrees Fahrenheit, and what will be the resistance of four feet of such wire when cold? C. C. G.

[17.] When you cut in resistance from a rheostat in the field coils of an exciter of an alternating current dynamo, do you increase or decrease the potential of the lamp circuit? W. F. B.

[18.] In running an incandescent dynamo as a motor do you cut in or cut out resistance in the rheostat to increase the speed? W. F. B.

[19.] Can I use the voltmeter of an alternating system for adjusting lamps on an 18-ampère 30-volt arc light circuit? The instrument reads to 60 volts. W. F. B.

[20.] Can you give me any rules for calculating approximately the ampère turns required for a given field with an average quality of cast iron such as is used in most dynamos? I have those given in Munroe & Jameison's Pocketbook, but they give no guide to the permeability most commonly met with. C. W. V. L.

[21.] How many ampères are required for a 52-volt Thomson-Houston incandescent lamp? C. W. V. L.

[22.] What are the thermo-electric relative positions of the following metals: aluminium, nickel, palladium? W. H. P.

[23.] If a motor designed for 110 volts constant potential be operated as a dynamo, would it generate 110 volts, and, if so, would it have to be run at the same average speed for which it was designed as a motor? C. F. T.

[24.] If a 100 volt, half ampère lamp be supplied with 50 volts and one ampère, would the result be the same? C. F. T.

[25.] In a shunt dynamo a rheostat is placed in the shunt circuit to regulate the potential; what would be the function of one placed in the main circuit? C. F. T.

[26.] Are there any other regulating devices for incandescent lamps except those having a variable resistance to be inserted in series with the lamps? F. C. S.

[27.] If there are two circuits, the voltage of which is the same, but in which one carries a large current and the other a small current, will the shock received by a man touching them be greater in one case than in the other? W. D. L.

[28.] What is the resistance of the human body? W. D. L.

[29.] By what method can the number of lines of force generated by a certain number of ampère turns be calculated? W. D. L.

[30.] How is the limit of magnetic saturation found? W. D. L.

[31.] What substances combine to the greatest extent the following qualities: High specific heat, high conductivity of heat, non-conductivity of electricity, and capability of withstanding high temperatures? I want to make an electric heater and would like to know what material to use outside of the wire, preferably a solid, at all temperatures below 600 degrees Fahrenheit? W. C.

[32.] Why are automatic regulators not practicable for use to prevent the burning out of motors on street cars, and for stationary work? If the burn-out is not instantaneous when the motor is new, is it found that the wire insulation gradually becomes charged so that a burn-out would come quicker? M. J. M.

[33.] How can I prevent my watch from becoming magnetized? I have to be around motors and dynamos considerably. R. T.

Answers to Correspondents.

Readers are invited to send discussions regarding or answers to the queries published in the column above, or with regard to any other live questions on electrical subjects. In answering questions please refer to them by their serial number. Correspondence must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. All correspondence should be as brief as is consistent with clearness. THE ELECTRICAL WORLD *assumes no responsibility for the opinions expressed by correspondents.*

[1.] The usual frequency used in alternating current systems in this country is between 100 and 150. The higher the frequency the smaller the transformer. The lowest frequency for running arc lamps is said to be about 50. That used in the Lauffen experiment was intended to be 40, but is stated by some to have been only 23. The Helois Company in Germany, representing the firm of Ganz & Company, of Austria, use 83. X. Y. Z.

[2.] If the frequency is given as 200 it means 200 complete cycles. But if it is said that there are 200 alternations it would mean 200 changes or a frequency of half that amount. X. Y. Z.

[3.] Testing an alternating current system containing transformers in circuit is unsatisfactory if done with a magnet, as the results are not sure, because the self induction of such large coils may tend to check the alternating currents from the magneto sufficiently to make it appear as if there was no ground, when there really may be one. Testing with a battery would be more satisfactory, and if care is taken it may be done while the circuits are in use. X. Y. Z.

[4.] If the resistance of a field magnet is 17 ohms the current which it takes is readily calculated from the electromotive force of the dynamo. Comparing this current with the total current will give you the desired proportion. X. Y. Z.

[4.] Where the resistance of the armature is one one-hundredth of an ohm and that of the field magnet shunt coils is 17 ohms, the current will divide itself into 1,701 parts; one part flowing through the shunt coils and 1,700 parts through the armature. S. H. R.

[5.] It cannot be stated that electricity travels with a fixed velocity. Some authorities even say it has no velocity at all. What might be termed the velocity of transmission on a long cable, for instance, depends on the condition of induction and static capacity, and, therefore, no definite value can be given for all cases. X. Y. Z.

[7.] The constant 10.61 is simply the resistance of one foot of copper wire one millimetre in diameter, and is derived from the specific resistance of copper. The constant 21.21 is simply double this, necessitated by using the distance D instead of the length of the wire L, which includes the return circuit, thus $L = 2D$. The true constant is slightly less than 10.61, which explains why 21.21 is not exactly double the former. C. H.

[8.] It is the self-induction of the primary circuit which develops a counter electromotive force almost equal to that impressed, and, therefore, prevents all but a small current from flowing. X. Y. Z.

[10.] The static charge from a driving belt will act the same as lightning on a small scale, and may injure the insulation by starting an arc. It cannot cause an open circuit except indirectly. It is always safest to provide a ground for such static charges. X. Y. Z.

[13.] A magnet can be made as large as you choose to build it. The distance to which its effect can be noticed will depend upon whether it is an open or a closed circuit magnet, and how delicate the apparatus is with which you detect it. Any copper wire may be used, depending on the electromotive force and current which are to be used.

News of the Week.

THE ELECTRIC LIGHT.

Westfield, N. Y., is to be bonded for $12,000 to pay for an electric lighting plant.

Richmond, Va., is to be bonded for $125,000 to pay for an electric lighting plant.

Lebanon, Pa., has voted by 1,169 to 191 in favor of a municipal electric lighting plant.

Eagle Grove, Ia.—The City Council has declared in favor of an electric light plant.

Melrose, Mass., is contemplating a bond issue of $75,000 to pay for an electric light plant.

Chambersburg, Pa.—Burgess Wood will give details of extension of the electric light system.

Braintree, Mass., has voted in favor of a bond issue of $30,000 to pay for an electric lighting plant.

Hull, Mass.—The sum of $2,500 has been appropriated for electric lighting to be put in this season.

Bellefontaine, O., is to issue $25,000 in bonds for the purpose of establishing an electric light plant.

Nahant, Mass., has voted to light the town by electricity. For further details write to the town clerk.

Rutledge, Delaware County, Pa., has decided to contract for street lighting, to be the best system obtainable.

Tillamook, Ore.—The equipment for an electric light plant has been purchased, and the plant will be put in operation as soon as possible.

Hamburg, Erie County, N. Y.—The Hamburg Water and Electric Light Company is contemplating the putting in of an electric lighting plant.

Lewiston, Idaho.—The Lewiston Water and Light Company will have its electric light plant for arc and incandescent lighting in operation soon.

Ewing, Mass.—Negotiations are pending for the purchase of the C. S. Stone property here to be used in running an electric light plant to be established.

Missoula, Mont.—A franchise has been granted to Frank and George Higgins and Wm. Houston for the construction of an electric railway and for electric street lighting.

Great Bend, Kan.—W. B. Grimes & Sons, of Kansas City, have been granted a franchise by the City Council to operate an electric light plant for arc and incandescent service.

Pontiac, Mich.—The Commercial Electric Light Company has made a proposition to the Common Council to sell the plant now in use for $20,000, and the question will be submitted to vote at the spring elections.

Milford, Del., has a model combined electric light and waterworks plant, recently purchased by the town council from Messrs. R. M. and W. T. Johnson. The capacity of the electric light plant has been doubled.

Bridgport, Tenn.—The Bridgeport Ice and Electric Company has let the contract to the Thomson-Houston company for a complete electric light plant, which is to be completed and ready for operation by May 1.

Ashton, R. I.—Village President Currier states that the reason of the non-appearance of electric lighting for this town and Berkeley is because they cannot get a company to supply them except under a nine years contract.

Decatur, Ill.—The City Council has granted a franchise to a new electric light company, of which Mr. Lewis E. Foster is secretary and treasurer. The equipment has been ordered and the plant will be installed at once.

Waltham, Mass.—A new electric light company is being organized, and when in operation will make a reduction in rates. H. M. Rider will be the manager of the new company. The stock has been nearly all subscribed.

Oberlin, O.—An ordinance to permit the Oberlin Gas and Electric Company to erect poles and wires in the streets and public grounds of the city for a system of electric lighting, heating and power has been adopted.

Cincinnati, O.—Sealed proposals will be received to April 12, for lighting by electricity the streets, alleys, lanes and public places of the city for a period of 11 years. Specifications to be had from Edwin Anderson, city clerk.

ELECTRIC RAILWAYS.

Buffalo, N. Y.—The secretary of the Board of Trade will give details of proposed electric road to East Aurora.

Coatesville, Pa., is contemplating an electric railway to Downingtown and an electric street lighting plant.

Great Neck, Long Island, N. Y.—Benjamin C. Hicks is at the head of a scheme to operate a street railway here.

Lockport, N. Y.—It is stated on the best authority that the Buffalo & Tonawanda Street Railway is to be extended to this point.

The Rochester (N. Y.) Electric Railway Company is installing two Thomson-Houston D 62 generators in its power house near Charlotte.

Lansdale, Pa.—Citizens are agitating for an electric road to Skippackville by way of Kulpsville and Harleysville, about ten miles and to cost $100,000.

Edison, Wash.—The Point Defiance, Tacoma and Edison Electric Railway Company's road will be equipped with electricity from Point Defiance to Edison, a distance of 10 miles.

The Camden (N. J.) Horse Car Company, it is stated, completed arrangements for extending its electric line to Merchantville. The contract calls for the completion of the work by the 1st of June.

Marlboro, Mass.—The Marlboro Street Railway Company has petitioned for right to extend its tracks to Hudson and Westboro, to be operated by electricity, and to issue bonds to the amount of $100,000.

The Union Electric Railway, of Saratoga Springs, N. Y., will build a five-mile extension to Saratoga Lake and the race course. Double-deck Pullman cars, with 25 h. p. Thomson-Houston W. P. motors will be used.

The Troy and Lansingburgh Railway has bought six Thomson Houston W. P. 50 motors to use on its lines between Troy and Cohoes. This line will be changed from horses to electricity as soon as the weather will allow construction to proceed.

Permission to Use the Trolley.—The New York State Railroad Commission has approved the application of the Brooklyn City & Newtown Railroad Company for permission to change its motive power to the trolley system on its Franklin avenue route.

Elizabeth, N. J.—A plan is on foot, it is stated, to connect Elizabeth and Newark by electric lines. The New Jersey Traction Company is interested, and the City Councils of both places have been asked to give the necessary permission for the construction of the line.

The Suburban Electric Railway Company's lines at Portland, Ore., it is stated, will be one of the best equipped electrical systems in the United States. There will be about 44 miles of electric lines, reaching to all points in Portland, East Portland, Mt. Tabor and Albina.

The Buffalo, Bellevue and Lancaster Railway has contracted with the Field Engineering Company to build its road. Ball steam plant, Brill company's cars, and Thomson-Houston motors will be used. This road goes through the New York Central town which is to be known as Depew.

Oakland, Cal.—The Thomson-Houston Electric Company has closed a contract with the San Leandro and Haywards Electric Railway Company to furnish certain electric equipments and appliances for the electric road to Haywards. The consideration for the appliances, etc., is $46,130, it is stated.

Boston, Mass.—The Committee on Street Railways has reported a bill to incorporate the Haverhill & Amesbury Street Railway Company, $250,000. For the purpose of purchasing the Salisbury Beach Street Railway, it may issue $300,000 six per cent. bonds, secured by mortgage on all its property, including the acquisition.

The Niagara Falls and Suspension Bridge Railway Company now operates about three miles with horses. It will build a mile-long extension through Suspension Bridge. The company has decided not to wait for water power, but to equip with electricity at once. The Cleveland Construction Company has the contract for construction. Brill company's cars and Thomson-Houston motors and generators will be used.

The Newton & Boston Street Railway Company has been granted a charter, and will construct an electric road from Newtonville to Newton Centre, Mass. It is authorized to use either the storage battery or the trolley system. The capital stock is $50,000. The directors are Austin R. Mitchell, Jasper N. Kellar, Samuel L. Powers, Horace B. Parker, James W. French, James L. Richards and Louis E. P. Smith, all of Newton, Mass.

MISCELLANEOUS NOTES.

Interesting, if True.—An English contemporary gives the specific heat of a mutton chop as 0.5 calorie, which is equal to about 1.5 foot pounds.

A Mine to be Operated by Electricity.—Arrangements are being perfected to light and run the Idlewild mine, two and one-half miles from Greenwood, El Dorado county, California, by electricity. Three dynamos and the necessary machinery are being installed. The drills and all the machinery will be run by electricity. It is claimed that ore can be milled at the low cost of forty cents per ton. This mine is familiarly known as the old Taylor mine. Electricity is now used in the St. Lawrence and Del Marcie mines of El Dorado county.

A Customs Decision as to Platinum.—The U. S. Board of General Appraisers have made a recent ruling in the case of Bruckmann & Lorbacher vs. Collector at New York.—"Platinum apparatus," imported April 27, 1891. The local appraiser returned the article in question as an "appliance for an electric cautery or cauterizing instrument used for medical purposes." It was assessed for duty at 45 per cent. under paragraph 215 N. T. as a manufacture of metal platinum. The importers claimed free entry as an "apparatus" composed of platinum and designed for chemical uses, under paragraph 682. Collector affirmed.

The Classification and Rules of the department of electricity of the World's Columbian Exposition and other information for the use of intending exhibitors are being sent out in circular form by the department and can be obtained by applying to J. P. Barrett, chief of the department, who states in a recent circular letter that he will be glad to furnish special information to those interested, and invites correspondence. In order that exhibitors in this department may make their preparations, it has been decided to immediately begin the assignment of space. Those who have not already made application will please do so at once. Immediate action on the part of exhibitors is the more necessary

because of the fact that the demand for space is many times in excess of the amount available. Foreigners will transact all business and apply for space to the government commissions of their respective countries.

The Electric Light Convention.—President James I. Ayer, of the National Electric Light Association, has already begun to make extensive preparations to entertain the delegates to the National Convention of the association, which meets in St. Louis next February, says the *Globe Democrat* in a recent issue. Isaac Taylor, the architect who has charge of the building of the new Mercantile Club house at Sixth and Locust streets, has promised to complete the building by February in order that the convention can meet there. The faculty of Washington University, the Mercantile Club, St. Louis Engineers' Club and the Merchants' Exchange will heartily co-operate in entertaining the delegates, among whom are many of the brainiest men in the country and men pre-eminent in the science of electricity. President Ayer received a letter recently from Mr. E. R. Weeks, general manager of the Kansas City Electric Light Company, instructing Mr. Ayer to call upon him for any assistance he may be able to render in making the convention a success. There will be about 300 delegates present.

Industrial and Trade Notes.

The Canton Steel Roofing Company, of Canton, O., has issued an illustrated descriptive catalogue and price list, which is very neat and contains much information in regard to the line of goods which the company manufactures.

The Rue Manufacturing Company, of Philadelphia, manufacturers of injectors, boiler washing and testing apparatus, steam valves and boiler checks, is sending out an illustrated descriptive catalogue and price list, which gives full, detailed information in regard to the extensive line of goods manufactured by the company.

The Thomson-Houston Electric Company, through its railway department, has issued a monthly bulletin for March, showing a list of street railways already using Thomson-Houston equipment and also a list of roads under contract. It also gives the total number of roads in operation and under contract as 222, total number of cars for roads in operation and under contract 4,319, total miles of track in operation 2,626.86. Other interesting facts concerning the equipment of street railway lines are referred to.

The Electric Appliance Company, of Chicago, has just closed arrangements for the exclusive Western agency for canvas jacket weather proof wires and interior conduit and will carry a large stock of both wire and canvas jacket flexible conduit. This material is all well known to the electrical trade. In anticipation of a heavy Spring trade the company is stocking up very heavily on standard lines of supplies, such as sockets, switches, cut outs, wires, etc., and will be prepared to meet any demand that can be made upon them.

The Interior Conduit and Insulation Company, of 42 Broad street, New York, is sending out a pamphlet to architects, builders, owners and others, containing cautionary notices in regard to the use of interior conduit systems, asserting its claim to control the use of interior conduits, and that it has the legal right to the following: To employ a system of tubes for interior electric lighting. To employ a system of electrical distribution in which a main circuit supplies a number of branches. To employ a system of tubes in which the two wires of a circuit are placed in a single tube. To employ a system of tubes in which there is a tube for each wire of a circuit.

The Short Electric Railway Company, of Cleveland, O., announces for February business orders for original equipment or for additional apparatus from the Beatrice Rapid Transit and Power Company, Beatrice, Neb.; Janesville Street Railway Company, Janesville, Wis.; the Spokane & Montrose Motor Railroad Company, Spokane Falls, Wash.; the Bloomington City Electric Railway Company, Bloomington, Ill.; the East Liverpool & Wellsville Street Railroad Company, East Liverpool, O.; the Braddock Electric Railway Company, Braddock, Pa.; the Georgetown & Tenallytown Railway Company, Washington, D. C.; the West End Street Railway Company, Rockford, Ill.; the Jamestown Street Railway Company, Jamestown, N. Y.; the South Covington & Cincinnati Street Railway Company, Cincinnati, O., and the Lincoln Street Railway Company, Lincoln, Neb.

The Wilmot & Hobbs Manufacturing Company, of Bridgeport, Conn., manufacturers of cold rolled strip steel, has received a large United States government contract for this material for use in the manufacture of United States mail lock hardware. This order was placed with them, it is stated, after a trial of various makes of cold rolled steel for this special work, extending over quite a period of time, and the government has adopted what the Wilmot & Hobbs Manufacturing Company terms its "extra special" stamping and drawing steel, as being the best for the purpose. This company has recently purchased the hot rolling mill plant of the Bridgeport Rolling Mill Company, which gives additional facilities for preparing special billets for the company's cold rolling mills and brings the annual capacity up to about 15,000 to 20,000 tons of hot and cold rolled strip steel. Mr. Albert N. Stanton, formerly principal owner and general manager of the Bridgeport Rolling Mill Company, has been engaged to manage this department of the company's works.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The Mather Electric Motors combine the highest efficiency and workmanship consistent with a reasonable first cost. Perfect automatic regulation of speed from no load to full load. For catalogue and information address E. T. Pardee, agent, 14 Butler Block, Syracuse, N. Y.

We would call the attention of amateur electricans and those engaged in experimental work to the advertisement of the Eureka Tempered Copper Company contained in this issue. They have something of interest to say, which will take only a moment's time, and may be of importance.

Messrs. W. H. Gordon & Company wish it distinctly understood that they have not gone out of the wire business. A recent notice in a trade paper mentioning the severance of one of their connections is calculated to create a wrong impression. They wish their friends to bear in mind that they have even greater facilities than heretofore for furnishing any grade or kind of wire needed. It should be borne in mind that on bare and insulated wire, line material, lamps, and several other specialties, Messrs. W. H. Gordon & Co. are manufacturers' agents, and are selling at factory prices.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 22, 1892.

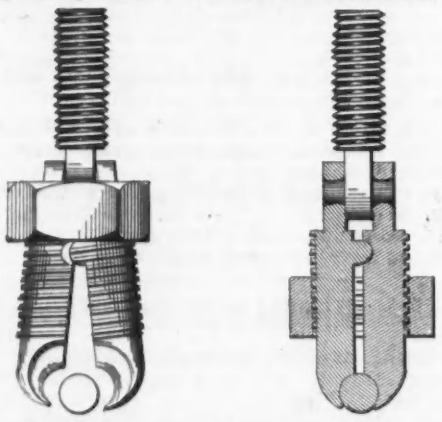
471,096. Wire Clamping Device; Orlando P. Briggs, of Chicago, Ill., Assignor of one-half to Charles L. Jenness, of same place. Application filed Sept. 12, 1891. In a wire clamping device the combination, with the two clamping members provided with externally threaded half shanks and an intermediate fulcrum or fulcra, of a nut adapted to fit said half shanks when assembled and to tilt said members upon said fulcrum or fulcra to cause the clamping members to grip or release the wire. (See illustration.)

471,100. Electrically Controlled Elevator; Andrew M. Coyle, of Washington, District of Columbia, Assignor to Nelson Hiss, of Baltimore, Md. Application filed May 23, 1891. In a system for controlling elevators electrically, the combination, with a starting and stopping mechanism, of a main electric circuit controlling the starting and stopping mechanism, a series of main circuit closers for the several floors of mechanism, landings and a series of magnets in branches of an auxiliary circuit for operating said circuit closers.

471,130. Thermostatic Instrument; Morris Martin, of Malden, Massachusetts. Application filed June 3, 1891. A thermostatic instrument having an active member adapted to form part of an electric circuit and one or more independent hollow terminals to form part of an electric circuit and a fusible connection joining said hollow terminal to the active member to complete the said circuit.

471,151. Trolley Wire Support; Elmer A. Sperry, of Chicago, Ill. Application filed July 6, 1891. In an integral device for supporting a trolley wire, a wire clamp, a portion designed to be secured to the supporting medium, and an elastic or yielding portion connecting the two.

471,155. Alternating Current Motor; Elihu Thomson, of Swampscott, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed August 17, 1891. An alternating current motor comprising an armature, field-coils inductively acting on said armature and connected to a single



No. 471,096.—Wire Clamping Device.

supply circuit, and a condenser shunting some of such field coils, whereby they are caused to lag behind the other coils in magnetic changes. (See illustration.)

471,190. Carbon Holder for Arc Lamps; Charles A. Pfluger, of Chicago, Ill., Assignor by direct and mesne assignments to the Standard Electric Company, of Illinois. Application filed Oct. 17, 1891. An arc lamp having a single carbon at one electrode with two or more distinct carbons rigidly secured to one and the same holder, so as to travel together at the other electrode, and means for keeping the points of such distinct carbons always substantially in contact with each other during the period of burning.

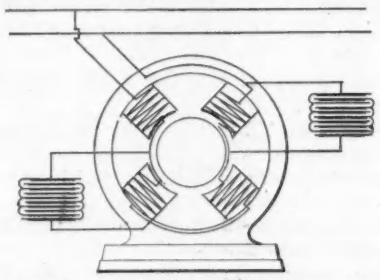
471,206. Trolley-Pole Catcher; Montraville M. Wood, of Chicago, Ill. Application filed June 4, 1891. A trolley-catcher, comprising a trolley normally upwardly held against the trolley wire, a rope whereby the same may be drawn down, means for winding the rope to bring the trolley down, ordinarily disconnected from the motor mechanism of the car, and a catch to throw such winding apparatus into operation, said catch adapted to be operated by the tightening of the rope.

471,230. Electric Railway Signal; Edgar C. Wiley, of Bristol, Tenn., Assignor of two-thirds to James A. Dickey and Napoleon B. Ainsworth, of same place. Application filed June 18, 1891. The combination, with a rotary commutator having a crank arm projecting up beside the rail and provided with toes, of a depressible spring-bar having lugs resting beneath the toes of the crank-arm.

471,234. Electric Arc Lamp; Hector Dewar, of Boston, Mass., Assignor to Albert W. Rounds, of same place. Application filed Sept. 15, 1891. In an electric arc lamp the combination of a non-magnetic floor, magnets secured thereon, an insulating strip between the magnets and the floor, having a depending block and adjusting screw mounted in the floor and passing through the said depending block.

471,237. Vibrating Electric Switch; Jacob S. Gibbs, of Hartford, Conn. Application filed July 3, 1891. In an electric switch, a contact lever with an angular hub and a reciprocating rod carrying spring devices, which pass over the angle in the said hub and press against the inclines on either side thereof for raising and lowering the outer end of the said contact lever.

471,242. Electrically Welding Metals; Auguste De Meritens, of Paris, France, Assignor by mesne assignments to the Thomson-Houston Electric Welding Company, of Boston, Mass. Application filed Nov. 8, 1887. The art or process of joining two



No. 471,155.—Alternating Current Motor.

pieces of metal together by a welding or soldering operation, consisting in forming an electric arc at those points only of the metal which are to be joined, the heating current being adjusted at said point to the required welding or soldering temperature.

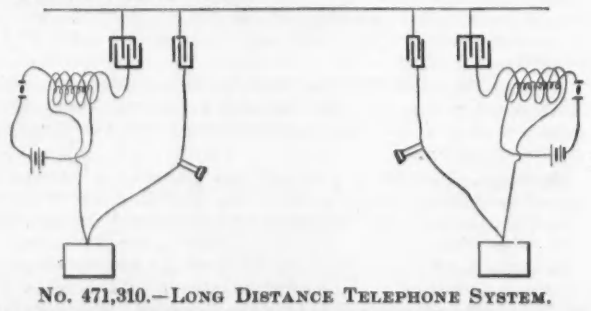
471,271. Electric Switch; Amandus Metzger, of New York, N. Y. Aplication filed June 6, 1891. The combination, with an insulating switch-base, of a circuit terminal consisting of a single piece of sheet metal having two arms extending from the base and having an arm embedded in the base, a second terminal, and a switch-arm adapted to connect said terminals.

471,296. Electric Signal for Railways; Eugene T. Turney, of Chicago, Ill. Application filed Nov. 10, 1890. In an electric signaling apparatus for railways, a contact-post, in combination with a switch lever arranged near the former, both connected up, a battery mounted on the engine, an insulated contact plate or bar also mounted on the engine, connected with said battery, and adapted to make contact with the post, an alarm arranged on the engine and set in operation when a circuit is closed by contact between the said post and plate, and a suitable device arranged on one of the cars of the train and adapted to set the switch lever in passing the latter.

471,302. Safety Device for Electrical Conductors; Julius Marx, of Nauheim, Germany. Application filed July 6, 1891. The combination of a receptacle, electrical terminals included therein at a distance from each other, and a compound in said receptacle of low resistance, which becomes less conductive or non-conductive upon increase of temperature, and which connects said terminals.

471,310. Long Distance Telephone System; Eugene Gwosdeff, of St. Petersburg, Russia. Application filed Feb. 15, 1889. A telephonic system for great distances, characterized by the following arrangements: the microphones and telephones connected with the line by means of separated condensers and connected with a return line by means of condensers, the electric capacity of which corresponds with the respective resistances of the two lines. (See illustration.)

471,311. Boiler Feed Alarm; Peter Kerekes, of Buda-Pesth, Austria-Hungary. Application filed March 18, 1891. In a boiler feed alarm, the combination, with a water reservoir mounted on the boiler, of an alarm apparatus mounted on said reservoir, of a sleeve provided with a plug, an insulated disc, secured in the plate shaped upper dilatation of the same, piston and opening, and at the top provided with electrical contacts and at the opposite end with a pane of easily fusible material, whereby when said pane melts a column of steam passes through the opening and by raising the piston into engagement with the contacts closes the electrical circuit.



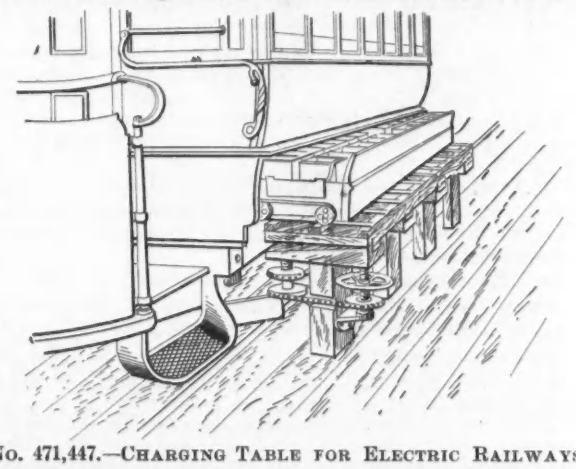
No. 471,310.—Long Distance Telephone System.

471,352. Telephone System; Anthony B. Ferdinand, of Oshkosh, Wisconsin. Application filed June 29, 1891. In a telephone or analogous system, the combination, with the main line or circuit and the instruments or stations thereon, of a device located adjacent to each of the said instruments or stations and connected with the main line, said device comprising mechanism under the control of a central office and serving at times to prevent the operation of the adjacent instrument, suitable means of enabling the central operator to move said mechanism into a position to permit the operation of said adjacent instrument, and suitable mechanism for automatically restoring said device to its normal position after said movements have been effected.

471,375. Conduit for Electric Railways; Francis O. Blackwell, of Boston, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Nov. 8, 1890. The combination in an electric railway conduit of the slot rails and transverse yokes placed at intervals, overhanging at their upper ends the air space in the conduit, and having an opening in said overhanging portion, with the insulators for the supply conductor removable from the conduit through said openings.

471,409. Apparatus for Electric Railway Signaling; Adoniram J. Wilson, of Port Chester, New York, Assignor to the Hall Signal Company, of Maine. Application filed May 23, 1891. The combination of a series of two or more secondary signaling circuits, one for each block or section, for actuating or controlling a signal or signals for such block or section, a series of four or more primary signaling circuits, two for each block or section, adapted to be actuated successively by a train while traversing the said blocks or sections, the first primary circuit of each block actuating or controlling the second primary circuit of that block and also actuating or controlling the secondary circuit of the preceding block and the second primary circuit of each block actuating or controlling the secondary circuit of that block.

471,410. Electric Railway Signaling Apparatus; Adoniram J. Wilson, of Port Chester, New York, Assignor to the Hall Signal Company, of Maine. Application filed June 15, 1891. In an electric railway signaling system, a series of home-signals, and a series of primary signaling circuits respectively operating or controlling said home-signals and themselves operated successively by the train in passing over the road, in combination with a series of distance-signals, electrically and mechanically independent of the home-signals, and a series of secondary signaling circuits respectively operating said distance signals, each of said secondary signaling-circuits having a circuit-breaker adapted to be operated by one of said primary signaling-circuits at a distance and having, also, a short circuit shunting the distance



No. 471,447.—Charging Table for Electric Railways.

signal itself and adapted to be operated by the next adjacent primary home signaling circuit.

471,447. Charging Table for Electric Railways; Edward P. Usher, of Grafton, Mass. Application filed Aug. 31, 1891. A charging table, comprising permanent supports adjacent to the car track and a top adapted to receive the batteries, such top being hinged at one edge and provided with means for adjusting the opposite edge of the table top vertically to correspond with the battery recess of the car. (See illustration.)

471,491. Trolley Wire Hanger; Thomas J. McTighe, of New York, N. Y. Application filed June 11, 1891. A clip for trolley wire hangers, comprising a metal plate adapted to be folded up around the wire, and having at its meeting portions one or more registering tongues and slots forming a keyway, in combination with a suitable key.

471,525. Automatic Electric Block System; Joseph A. Carlton and Henry L. Johnston, of Atlanta, Ga. Application filed June 16, 1891. In an automatic electric block system a light circuit cut in two places, one break held normally closed by a spring terminal, and the other held normally open, but adapted to be closed by contacts carried by a lever set alongside the track, and adapted to be operated by a train, and carrying an armature and an electromagnet in circuit, so set as to attract said armature on the completion of the circuit by the proper movement of the lever, and hold it until the circuit shall be broken by the disruption of the spring terminals by the passage of the train.

471,526. Disc Carbon for Arc Lamps; Hosea W. Libbey, of Boston, Mass. Application filed Oct. 17, 1890. A disc carbon, the perimeter of which is of spiral form.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.